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Volume 65 • number 8 AUGUST 1956

JOURNAL of the
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Entered as second-class matter January 15, 1930, at the Post Office at Easton, Pa., under the Act of March 3, 1879, and published monthly.

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Printed by Mack Printing Company, Easton, Pa.

Journal of the Society of Motion Picture and Television Engineers

VOLUME 65 • NUMBER 8 • AUGUST 1956

Control of Fluorescent Screen Dot Size for Color TV

By SAM H. KAPLAN

Methods of fabricating dot fluorescent screens for color television mask-type tubes are summarized, and the dot size control factors associated with the different methods are explored. Special emphasis is given to screening factors for focus mask-type tubes which have high-transmission masks. The tube and mask geometry is studied, and the effect of light-intensity gradients across the dot image as a function of light source size is considered. From these studies, and a knowledge of the physical characteristics of the binder and phosphor materials, an optical method of dot-size control is developed using photographic exposure time and light source size as the parameters. Lastly, annulus-shaped light exposure sources are considered and are shown to produce images having improved size control characteristics.

IN THE PARALLAX mask-type color tube, a spherical mask containing approximately 400,000 apertures in a triangular array is used as a masking member to ensure that each of the three electron guns writes its proper color on the screen. The screen consists of triads of red, green and blue phosphor dots aligned behind each aperture, making a total of 1,200,000 fluorescent phosphor dots. Due to parallax, each gun "sees" only its proper set of dots. Because each mask differs slightly due to variations in mounting, stamping, fittings, etc., the mask destined for any particular tube must be used in the fabrication of that tube. This non-interchangeability prevents the use of master plates in exposing the screen. In some types of mask color-tubes, such as post-deflection focusing types, the mask apertures are considerably larger than the nonfocusing type tubes. Because of this, it is difficult to control dot size, which control then becomes very important. This paper is concerned primarily with the screening problems of such tubes. In addition to dot-type screens and masks, some tubes have band-type screens and wire-type masks.

Photoscreening

The formation of tricolor phosphor screens on the spherical inside surface of cathode-ray tubes has been successfully accomplished only by direct photographic methods. The aperture mask destined for the particular picture tube is essentially the photographed member in fabricating its own screen. The screen is then an exact optical enlargement of the aperture mask. Photographic methods all depend on the photo-insolubilization of an organic colloid by light. Organic resinous colloids such as gelatin, gum arabic, carboxy methyl cellulose, polyvinyl alcohol, etc., which are water soluble, become insoluble when properly sensitized and exposed to actinic light. An image of insoluble resin remains after the unexposed resin is dissolved and washed away. The usual resin used for fluorescent screens is polyvinyl alcohol. The aperture mask itself is made by this same type of photographic process, the resinous image acting as a resist to protect parts of the mask from the action of the solution used to etch the apertures. The etching of line cuts and halftones in the graphic arts is also based on this process.

Phosphors used in color television are insoluble inorganic crystalline powders whose average size is 3–10 μ which is quite coarse compared to color pigments. Suitable materials are zinc sulfide activated by Ag for blue, zinc silicate activated by Mn for green, and zinc phosphate activated by Mn for red. In making the screen, three methods are used:

(1) The phosphor is dispersed in and applied with the photo-binder material.

(2) The phosphor is applied first, say, by liquid sedimentation, and the photo-binder applied over the phosphor. The resin in this case soaks between the phosphor grains and under the parts of the grains not touching the glass. In either case, the hardening of the binder fixes the phosphor. Since the phosphors are high refractive index materials, they reflect and scatter the exposing light, causing larger screen images and necessitating longer exposures to harden the resin layer clear through to the glass-resin interface. Of course, exposure is from the resin, rather than the glass, side. The glass-resin interface, receiving the least light, is the last to insolubilize, and if not fully insolubilized, the dots wash away.

(3) The third method makes use of variations of the so-called "powder process" wherein the tacky surface of the resin is used to fix the phosphor. In this process, the clear binder is applied and is exposed just enough to insolubilize the resin, but not to fully harden the surface. Since there is no phosphor to absorb and scatter the exposing light, and since the resin needs only to be insolubilized but not hardened, short exposure times and images no larger than the projected optical image result. Then, after exposure, the phosphor may be applied by liquid sedimentation. When large aperture masks are screened, the third method gives the best control since the absence of light scattering phosphors can produce smaller images where such is necessary.

The screening is repeated three times, once for each phosphor group. For each exposure, the exposing light is shifted to the positions to be occupied later by the electron gun beams.

Methods of Screening Small Dots

The screening of small aperture masks presents no difficulty as the screen dot is much larger than the aperture. As the apertures become larger as for focus mask tubes, screening becomes more difficult since the screen dot size remains constant. One mechanical method of screening large aperture (focus) mask tubes is to electroplate the mask to close up the apertures and then, after screening, de-electroplate or chemically etch

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(Revised paper received on June 11, 1956.)

away the plated coating, thus restoring the larger aperture size. Another mechanical approach is to leave on the mask the photo-resist which is used in the original etching of the mask apertures. The mask apertures are made small, but after screening the mask is etched further to enlarge the apertures to the desired size and the resist is then removed. Interestingly enough, the photo-resist used in making the mask can go through the stamping operation necessary to form the mask into a section of a sphere without cracking or peeling. This method works quite well and is simpler than the first method.

The simplest method of dot-size control is an optical method involving control of exposure time in conjunction with the proper choice of light source size, particularly if the clear resin (without phosphor) method is used in making the screen.

Mask Geometry and Light Transmission

Consider a tricolor dot-type screen composed of tangent screen dots of size p (Fig. 1). The aperture mask has apertures of diameter A with center to center spacing of l. The web w between apertures is then $w = l - A$ (Fig. 2). Now consider the mask, screen and electron source relationships (Fig. 3). The projected image p' of A by an infinitesimally small electron or light source is

$$p' = A\left(\frac{c}{c-d}\right) \tag{1}$$

Along a horizontal row on the mask, the aperture-to-aperture spacing is $\sqrt{3}l = \sqrt{3}(w + A)$. The projected image of this equals $\sqrt{3}(w + A)\left(\frac{c}{c-d}\right)$, and this covers three dots on the screen or $\sqrt{3}(w + A)\left(\frac{c}{c-d}\right) = 3p$

$$p = \frac{(w+A)}{3}\left(\frac{c}{c-d}\right) \tag{2}$$

The light transmission T of the mask is

$$T = \frac{\pi}{2\sqrt{3}}\left(\frac{A}{l}\right)^2 \tag{3}$$

In a straight shadow-mask tube, if there were no mechanical or electrical spreading or shifting of the electron beams, the aperture size A for a tricolor tube could equal $\frac{l}{\sqrt{3}}$ and the mask transmission would become $\frac{\pi}{6\sqrt{3}} \times 100\%$ or 30.2%.

To provide for tolerances, the diameter A of the mask aperture is reduced. This lowers the effective transmission to between 11 and 14%. To increase the usable mask transmission, the mask may be made to focus electrically the electron beam down in size, permitting larger sized apertures, and hence, more transmission and brightness. Gains of 2 to 3 or better in transmission (28 to 42%) for aperture-type focus masks to as high as 90% in wire-type masks become possible. Focus masks of this type operate by using voltage differences to create a focusing field between the screen and the mask and may be used with or without an auxiliary collector mesh located between the electron gun and the aperture mask. They are often called post-deflection focus-type tubes.

In the usual 21-in. and 22-in. straight parallax mask color tubes, the mask

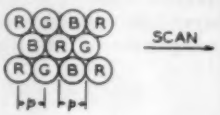

Fig. 1. Phosphor-dot type of screen.

aperture spacing $l = 0.028$ in., while the aperture diameter A is about 0.0105 in., giving a transmission of 12.7%. The projected aperture size p', on the screen, is 0.01085 in., but for full utilization of the screen area, the dots should be enlarged to 0.0167 in. so as just to touch one another. Focusing-type masks may have apertures of 0.015 in. (26%) to 0.023 in. (61%). (The collector, if used, reduces the final transmission to a lower value.)

Geometry of Exposure

In Fig. 4 a light source of size s is used to expose the screen. The image of aperture A cast by light source s consists of a center section p_a which "sees" the entire exposing source light s, and hence is of constant intensity. An annulus of light of diminishing intensity exists around this area, the maximum size being p_l where the light has dropped to zero. The diminishing intensity is caused by this portion of the image "seeing" lesser and lesser portions of the exposing light source s as the edge of the image is approached. This can be compared in reverse to the umbra, penumbra type shadow effect in astronomy. In this figure, p' is the optical projection of aperture A, and would be the size of the image if an infinitesimally small-sized exposing light were used.

It will be instructive to define analytically the boundaries of the hole penumbra:

$$p_a = p' - \Delta p \tag{4}$$

and

$$\Delta p = \left(\frac{d}{c-d}\right)s \quad \text{from (1)}$$

$$p' = A\left(\frac{c}{c-d}\right) \tag{5}$$

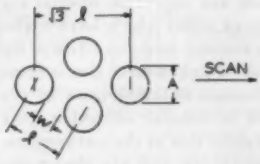

Fig. 2. Aperture mask for dot screen.

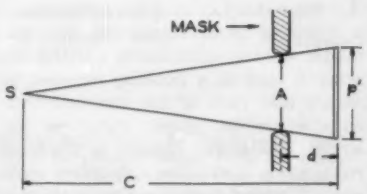

Fig. 3. Projective enlargement of mask apertures.

Therefore,

$$p_a = \frac{Ac - ds}{(c-d)} \tag{6}$$

Likewise,

$$p_l = p' + \Delta p = \frac{Ac + ds}{(c-d)} \tag{7}$$

We can then obtain the size of the light source s either from (6) or (7).

$$s = \frac{p_l(c-d) - Ac}{d} = \frac{-p_a(c-d) - Ac}{d} \tag{8}$$

The size of the web w between aper-

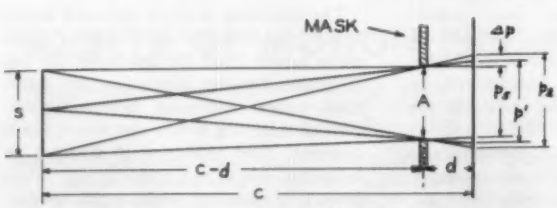

Fig. 4. Light-exposure geometry for a single aperture.

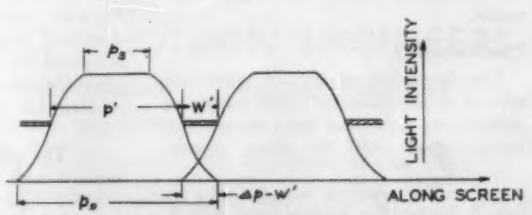

Fig. 5. Light-intensity variations along screen for two projected apertures.

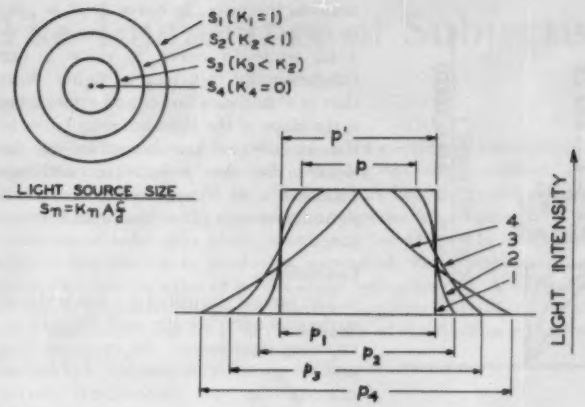

Fig. 6. Light-intensity curves for different-sized light sources.

tures affects the range of dot sizes obtainable. The shadowing or graduated image depends upon the web partially shadowing the image exposure light. Consider the illustration in Fig. 5, p' and w' are the projected images of aperture A and web w, and

$$w' = w\left(\frac{c}{c-d}\right) \tag{9}$$

It is seen that the images from adjacent apertures overlap in this case. Overlapped images should be avoided if at all possible. To avoid overlap, the web image w' must be equal to or greater than the image enlargement caused by light source size s.

For no image overlap

$$\Delta p \leq w' \tag{10}$$

or

$$s\left(\frac{d}{c-d}\right) \leq w\left(\frac{c}{c-d}\right), \; s \leq w\left(\frac{c}{d}\right) \tag{11}$$

The ratio of web to aperture is thus seen to be quite important since the maximum and minimum dot sizes for no overlapping of the images become

$$p_l = (A + w)\left(\frac{c}{c-d}\right) \tag{12}$$

$$p_s = (A - w)\left(\frac{c}{c-d}\right) \tag{13}$$

The smaller the web, the less the range of dot size obtainable by exposure control. If the web is equal to the aperture A, then by using a light source size s to give $\Delta p = p'$, we can have a range of dot sizes from zero to $2p'$

$$p_s = p' - \Delta p = 0 \tag{14}$$

$$pl = p' + \Delta p = 2p' \tag{15}$$

Since the light source size $s = \Delta p\left(\frac{c-d}{d}\right)$

$$s = A\left(\frac{c}{c-d}\right)\left(\frac{c-d}{d}\right) = \frac{Ac}{d} \text{ in this case} \tag{16}$$

Equation (8) gives the minimum light source size needed to obtain small dots by exposure control. Larger-sized light sources may be used with proper intermediate exposure to obtain the same size of screen dots.

The Light-Intensity Gradient

Small dots can be produced by enlarging the light source by different amounts, but larger source sizes make the image dot size very sensitive to exposure conditions. The light distribution across the phosphor screen plate must be quite uniform, and variables affecting the binder sensitivity must be controlled since sensitivity varies with humidity, sensitizer concentration, layer thickness, etc. The question must be asked — what factors render the exposure least susceptible to variations in light intensity or photo-binder sensitivity? A choice in the size of the light source must be made, since a larger-sized light source at a given exposure may yield the same correct size of dots as a smaller source at another exposure. Consider Fig. 6 illustrating light sources s_1, s_2, s_3, s_4 and their corresponding resultant distribution of light across an individual screen dot. In this figure

p' = projected aperture size $A\left(\frac{c}{c-d}\right)$

p_1, p_2, p_3, p_4 = maximum image size for sources s_1, s_2, s_3, s_4

1, 2, 3, 4 are the light-intensity curves for sources s_1, s_2, s_3, s_4

p = desired dot size on screen

where $p_n = p' + \Delta p_n = p' + s_n\left(\frac{d}{c-d}\right) = \frac{Ac + s_n d}{c-d}$ $(n = 1, 2, 3 \text{ or } 4)$

Here $p_4 = 2p'$ and $p_1 = p'$ p_2 and p_3 being in between p_1 and p_4.

It is evident that the correct dot size p can be obtained by only the three light sources s_2, s_3, s_4 (s_1 yielding only a dot of size p_1) by proper exposure; where the insolubility threshold of the photobinder is at the edge of the desired dot size. However, the rate of dot-size variation with exposure is a function of the gradient or slope of the light distribution across the dot. Curve 1 has the steepest gradient and will produce the least dot-size variation, while curve 4 produces the most. This can be seen better by replotting this graph in terms of reciprocal intensity units. By the reciprocity law, the exposure time necessary

$$t = E_t/I \tag{17}$$

where I = intensity, t = time, E_t = exposure threshold.

Figure 7 shows image size as a function of exposure time for a given insolubility limit. To produce a dot of size p, smaller than p', source sizes s_2, s_3 or s_4 may be used; the exposure times then will be t_2, t_3 and t_4, respectively. The least sensitive of these three to exposure variations is seen, by inspection of Fig. 7, to be the curve with the steepest slope, No. 2. The source size for this case s_2 is obtained from equation (5).

$$s = \Delta p\left(\frac{c-d}{d}\right) \tag{18}$$

which is the minimum size light source as well as yielding the steepest slope. Considerably larger-sized sources make

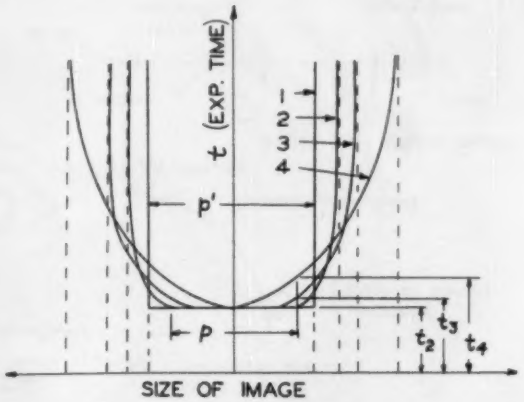

Fig. 7. Image size as a function of exposure time.

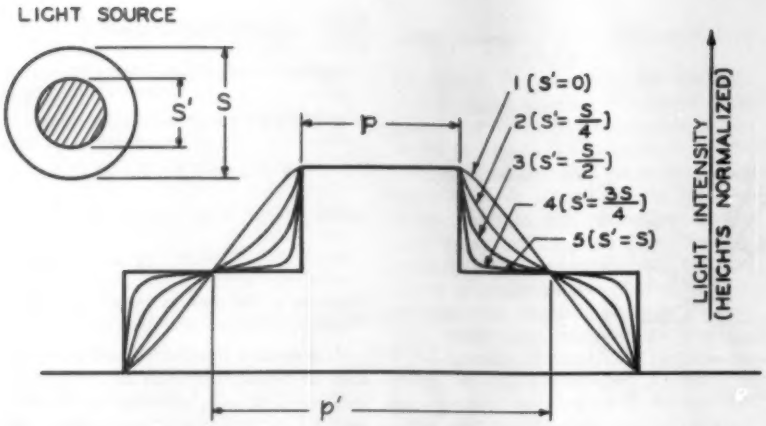

Fig. 8. Light-intensity curves for annulus-type light sources.

the screen-dot size very sensitive to exposure and sensitizing conditions. The same equation can be given in terms of A, l, and w, the mask parameters used in practice as follows:

$$s = \pm\left[\frac{w + A}{\sqrt{3}} - A\right]\frac{c}{d} = \pm\left[\frac{l}{\sqrt{3}} - A\right]\frac{c}{d} \quad (19)$$

For dots larger or smaller than the projected aperture p', the least variation of dot size with exposure can be obtained from the above equations, with due regard to sign. In the enlargement case, the dot is less sensitive to exposure variations, because the slopes are steeper as the asymptote lines are approached. In actual practice, the source size should be somewhat larger than that given above. For small dot exposure, this is necessary to avoid operating too close to the exposure threshold where variations of exposure can cause dots to wash away. For large dot exposure the source size should be larger so as to reduce the exposure time.

Annulus-Shaped Light Sources

The preceding analysis applies particularly to uniform-intensity circular light sources as generally used. It is evident that the greater the aperture size A in relation to screen-dot size p (other parameters being unchanged) the larger the light source size s required. This produces lower light-intensity gradients in the dot images and makes the control of dot size more susceptible to exposure and sensitivity variations. The use of light sources other than the uniform circular ones considered can produce larger light-intensity gradients and may be used where such may be desirable. An annulus ring of light of proper proportions will produce such an effect. Figure 8 is a composite illustration of the light distribution of five annulus light sources of size s and having inner concentric areas s' blocked out. The blocked out portions s' reduce the amount of light available and require longer exposure. In Fig. 8 these curves have been normalized to constant height. In curve 1, $s' = 0$ and the light source is the same as previously described and of uniform intensity. In curve 2, $s' = s/4$; in curve 3, $s' = s/2$; in curve 4, $s' = 3/4s$, while in curve 5, $s' = s$ (an infinitesimally thin ring of light). Note that as s' becomes larger and approaches s, the slope of the light-intensity curve in the vicinity of the boundary of the desired dot size p increases and approaches ∞ as s' approaches s. Such a light source can prove desirable in some cases.

Conclusions

The optical control of dot size is shown to depend upon the size and shape of the exposing light source, the exposure time and the presence or absence of phosphor materials in the photo-binder during exposure. Various sizes of exposing light sources may by proper exposure-time control yield the same correct-sized screen dot. By the proper selection of the exposing light size the desired screen dot size can be obtained with least susceptibility to process variations. The use of clear photo-binders make possible smaller dots because of the lack of light scattering and image enlargement by the phosphors. Annulus-shaped light sources are shown to have better process control characteristics than uniform-intensity sources.

Bibliography

1. H. B. Law, "A three-gun shadow-mask color kinescope," *Proc. I.R.E., 39:* 1186–1194, Oct. 1951.
2. N. F. Fyler, W. E. Rowe and C. W. Cain, "The CBS Colortron: a color picture tube of advanced design," *Proc. I.R.E., 42:* 326–336, Jan. 1954.
3. Sam H. Kaplan, "The theory of parallax barriers," *Jour. SMPTE, 59:* 11–21, July 1952.
4. J. E. Mack and M. J. Martin, *The Photographic Process,* McGraw-Hill Book Co., New York, pp. 329, 451 and 457 (1939).
5. M. E. Amdursky, R. G. Pohl and C. S. Szegho, "A new high-efficiency parallax mask color tube," *Proc. I.R.E., 43:* 936–943, Aug. 1955.
6. Otto H. Schade, "Image analysis in photographic and television systems (Definition and Sharpness)," *Jour. SMPTE, 64:* 593–617, Nov. 1955.

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By E. M. LOWRY
and J. G. JARVIS

The subjective phase of tone reproduction requires a knowledge of how the eye reacts, that is, the visual response under a given set of conditions. Two instruments which have proven useful for obtaining this knowledge are a visual sensitometer and an adaptometer. The particular response investigated and reported is the luminance of subjective black, which may be defined as that value of luminance which is just too low to produce a perceptible visual impression under the luminance distribution existing in the scene being viewed. A fairly simple empirical scheme is proposed for predicting the luminance of subjective black from two easily measured quantities: the luminance of the fixation point and the average scene luminance.

THE SUBJECTIVE IMAGE of an object or scene, formed by the eye and the complex nervous system of which it is a part, is affected by many factors. One factor of considerable importance which, in a large measure, controls the sensitivity of the eye is adaptation or adjustment to the intensity and quality of the stimulating light. In the laboratory, adaptation can be quite rigidly controlled, but, in viewing an ordinary scene, the converse is true. Particularly out-of-doors, the lighting is seldom constant, and an infinite variety of luminance patterns is encountered. As the eyes sweep from point to point in the field of view, the adaptation level is continually changing and becomes a function, not only of the average luminance of the scene, but also of the luminance of the point of observation. A convenient and not too difficultly determined indicator of the state of adaptation is the threshold of vision under the particular viewing conditions. This indicator we have chosen to call "the luminance of subjective black," and its measurement, together with some of the conditioning factors, is the purpose of this paper.

The experimental technique described in an earlier paper[1,2] has been followed with some extension and modification, in the present investigation. A part of the earlier paper reported an attempt to correlate data obtained in the laboratory with measurements in the field. The agreement between the two was not satisfactory, and therefore the present study was undertaken in an effort to resolve the differences. Previous laboratory measurements were made with a test field of 2°, and the field of the adaptometer subtended an angle of but 22′ at the eye. Since there is considerable evidence that the size of the test field affects visual performance, one of the first problems was to determine its effect on the luminance of subjective black with surround luminance as a parameter.

The Visual Sensitometer

For this work, we employed the visual sensitometer previously mentioned,[1] which provides a means of rigidly controlling the luminance pattern of a visual field consisting of two parts, the "test field" and the "surround."

The sensitometer is basically half of a 1-m sphere (Fig. 1). Its inner surface is painted a matte white and is uniformly illuminated through a variable slot by an annular arrangement of lamps. With this arrangement, luminances up to 1000 ft-L are possible. The observer's eyes are located near the geometric center of the sphere and his head is held in position by an adjustable chin-and-forehead rest. Vision is binocular and, since it is unrestricted by artificial pupils, it corresponds to the actual manner in which the eyes are used when viewing a scene. The field of view is completely illuminated because the hemisphere has a conical cover with enough of the apex removed to allow the head to be partly admitted. The visual field then subtends an angle which, in some directions, is slightly more than 180°. A port in the center of the hemisphere permits the insertion of apertures of various diameters, and these apertures admit light from an optical bench at the rear. Intensity of light from the bench is controlled by a turret of neutral-density filters and by a neutral-density wedge. A rotating sector interrupts the light so that it can be seen $\frac{1}{5}$ sec each second. This time interval was chosen as being sufficiently long to allow perception of the flash with negligible effect on the adaptation of the eyes.

The observer sees a small, dark, circular spot in the center of the large, uniformly illuminated surround. This spot is physically black except when the sector admits light. By means of remote controls, the observer can reduce the luminance of the flashing light until it just disappears. When the point of disappearance is reached, the corresponding wedge position is recorded automatically by a tape perforator. The luminance of the test spot at disappearance is the luminance of subjective black for the existing surround.

Since it seemed desirable to confine the measurements to a determination of the threshold without the complication of working against time, the subject was allowed as long as he wished in making his judgments. Ten settings were made by each observer for each size of test field and surround luminance. The luminance of subjective black was plotted as a function of aperture size for surround luminances of 0.0 to 3.18 log ft-L (Fig. 2). The figure demonstrates

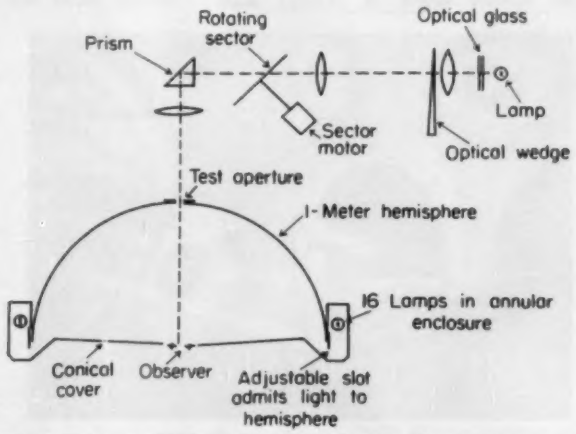


Fig. 1. Horizontal section of modified visual sensitometer.

Communication No. 1815 from the Kodak Research Laboratories, presented on May 4, 1956, at the Society's Convention at New York, by E. M. Lowry (who read the paper) and J. G. Jarvis, Research Laboratories, Eastman Kodak Co., Rochester 4, N.Y. A portion of the data included in this paper was submitted to the University of Rochester, by J. G. Jarvis, in partial fulfillment of the requirements for a Master's Degree.
(This paper was received on May 24, 1956.)

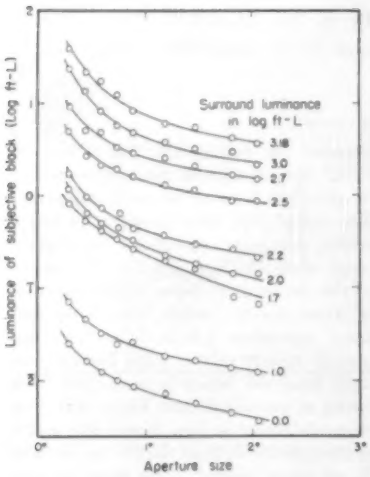


Fig. 2. Luminance of subjective black as a function of surround luminance and aperture size.

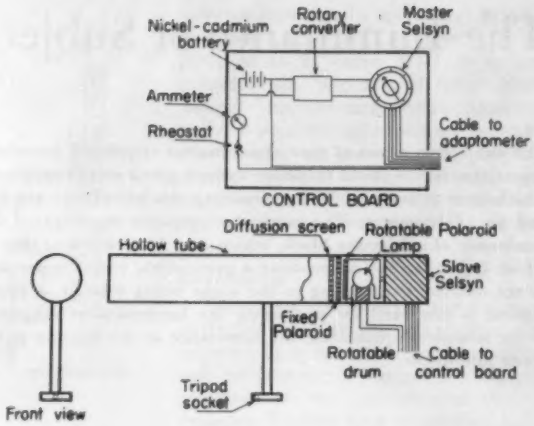


Fig. 3. Adaptometer and control board.

that the luminance of subjective black is indeed quite sensitive to the size of the test aperture since the threshold luminance increases approximately 0.6 log unit for a decrease of the test field from 2° to 22′.

The Adaptometer

For the purpose of measuring the threshold under field conditions, the adaptometer described by Lowry[1] was modified somewhat. Figure 3 is a diagram of the modified instrument. In the previous instrument, the luminance of the test spot was controlled by adjusting the lamp current, while, in the new one, control of intensity at constant lamp current was achieved by rotating a Polaroid filter with respect to a second, stationary filter. Both Polaroid filters were located between the lamp and the ground-glass viewing screen. Rotation of the Polaroid filter was accomplished by a pair of Selsyn synchromotors. One of the pair, the slave Selsyn, was attached to the movable Polaroid filter; and the other, the master Selsyn, was located on the control panel. A circular scale divided into 100 equal parts and fastened to the master Selsyn was calibrated throughout its length in footlamberts, by measuring the luminance of the adaptometer spot with a modified Macbeth Illuminometer.[3]

The dimensions of the adaptometer tube were such that it subtended an angle of 22′ at the eyes of the observer at a distance of 25 ft. In Fig. 4 the adaptometer is shown on its tripod set up so that the tube is in line with the fixation point in the scene. The observer, viewing binocularly (Fig. 5), adjusted the luminance of the test spot in the adaptometer and at the same time turned the lamp current on and off with a microswitch until the light could no longer be seen flashing. The luminance of the test spot at disappearance was that of subjective black for the particular point in the scene.

The actual luminance of the area immediately around the fixation point was measured with the modified Macbeth Illuminometer. The Illuminometer was fitted with a well-baffled telescope which reduced the field of view to approximately ½°.

A 5- × 7-in. camera set up near the control panel was used for making a negative of each scene, and the exact locations of the fixation points were recorded on a sketch made on a diffuse overlay covering the ground glass of the camera. During the measurements, the average scene luminance was monitored by an exposure meter clamped to the camera.

Measurements of subjective black were made by two observers, and five settings were made for each fixation point. From five to ten fixation points were selected in each scene. Photographs of five of the nine scenes visited are shown in Figs. 6–10. The small circles on each indicate the position of the fixation points.

Figure 11 is plot of all the luminances of subjective black for the nine scenes observed in the field during the current investigation, against the luminance of the area immediately surrounding the fixation point. The scatter of points represented on the graph is much the same as that found by Lowry.[1] On the same graph are plotted curves representing the thresholds for 22′ and 2° test apertures with a full surround of 180°, derived from the data of Fig. 2.

A straight line drawn through the scatter of points in Fig. 11 intersects the

Fig. 4. The adaptometer, as seen by an observer.

Fig. 5. The adaptometer, control panel and observer.

curve for 22′ at a value of surround luminance quite near the average of all the average scene luminances. It appears that the field data agree fairly well with the laboratory data for a full surround when the fixation point in the scene has the same luminance as the average scene luminance, and when the test apertures are the same size. When the point of fixation has a lower luminance than the average scene luminance, the threshold is higher than one would expect. Similarly, when the point of fixation has a higher luminance than the average scene luminance, the threshold has a lower value than would be expected.

The statement in the preceding paragraph suggests an empirical approach to the problem of predicting the luminance of subjective black for any scene, as follows: Figure 12 is a replot of Fig. 11 with the data points omitted. The intersection, C, of line D and Curve A occurs at the average scene luminance. Other lines may be drawn parallel to line D for different average scene luminances. Once the line has been chosen, predicted thresholds can be read from it. The data from all scenes have been treated by this empirical method and plotted in Fig. 13, with the predicted thresholds as ordinate and the observed thresholds as abscissa. If the correlation were perfect, all points would have fallen on the straight line. In order to apply this method, only two field measurements are necessary, namely, the luminance of the fixation point and the average scene luminance.

As a test of the method, the luminance of subjective black was measured for two additional scenes. These were in rather

Fig. 6. Scene 5.

Fig. 7. Scene 6.

Fig. 8. Scene 7.

Fig. 9. Scene 8.

Fig. 10. Scene 9.

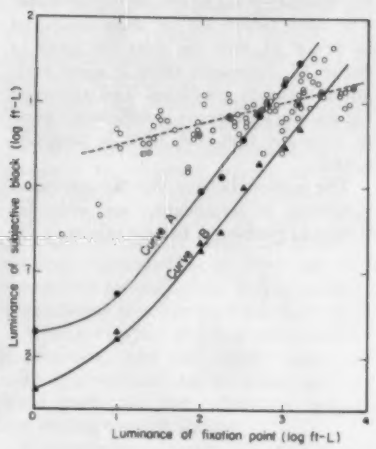


Fig. 11. Field data for Scenes 1 to 9. Laboratory data for a uniformly illuminated surround filling the full visual field (180°) and for central test apertures of 22′ and 2°.

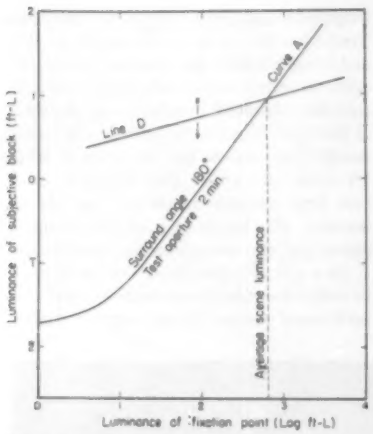


Fig. 12. Empirical method for predicting the luminance of subjective black for any fixation point in a scene.

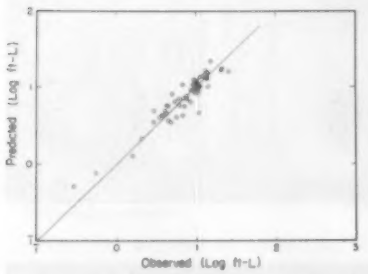


Fig. 13. The luminance of subjective black predicted on the basis of an empirical scheme vs. observed values.

heavily shaded areas, so that the average luminance was lower than for those from which the data in Fig. 11 were obtained. The results have been plotted in Fig. 14. Lines A and D are the same as those in Fig. 12, while those labeled 11 and 12 have been drawn parallel to D, intersecting line A at the value of average luminance for Scenes 11 and 12, respectively, and, according to the method suggested, represent the locus of the predicted values of subjective black for any fixation point in the particular scene. The open circles are for those measured in Scene 11 and the dots for those in Scene 12. Although there is some variation between predicted and observed values, the agreement is sufficiently good to indicate that the idea is basically sound.

The authors believe that the approach suggested is significant, not only for threshold problems, but for others in the

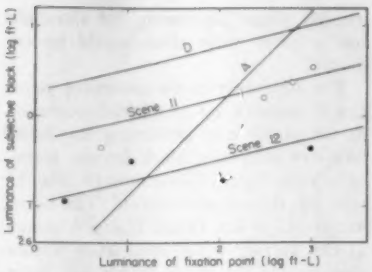


Fig. 14. Field data for Scenes 11 and 12. ● = Scene 11, ○ = Scene 12.

field of vision. Most data which have been published on visual acuity, contrast sensitivity, etc., have been determined for uniformly illuminated surrounds. The ability of an observer to detect a luminance difference in a complex scene or to recognize detail might well be studied by a similar method.

It is rather generally accepted by workers in the field of vision that the luminance within a few degrees of the fixation point is particularly important in governing visual sensitivity.[4–6] During the present investigation, additional experiments were performed on the visual sensitometer to determine the effect of areas outside the fixation point on the value of the threshold. A series of masks was arranged in the hemisphere of the sensitometer to reduce the size of the surround from its full value of 180° to values as low as $\frac{1}{2}$°. Figure 15 is a plot of threshold luminance against surround angle with three different surround luminances as parameters. The three curves have almost the same shape and demonstrate that the area within a few degrees of the fixation point has the greatest influence on the value of the threshold.

In order to form a better idea of the contributions made by various areas in the surround, the curve for 2.0 log ft-L has been divided into three equal log threshold increments, beginning at $\frac{1}{2}$°. The starting point of $\frac{1}{2}$° was chosen because it represents the area photometered by the Illuminometer for each of the fixation points in the field, and because all curves have identical shapes above this point. From this division, it can be seen that the area from $\frac{1}{2}$° to $\frac{9}{10}$° has about the same effect on the value of the luminance of subjective black as the area from $\frac{9}{10}$° to 8°, which, in turn, is about as effective as the remaining area of the visual field, i.e., from 8° to 180°. In other words, although the

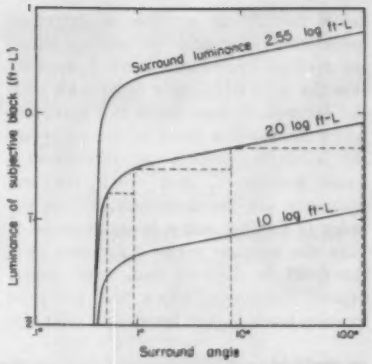


Fig. 15. Luminance of subjective black as a function of surround angle and luminance.

luminance within a few degrees of the fixation point is particularly important in governing the threshold, if there are significantly higher luminances in the peripheral areas of the scene, they may become large contributors to the value of this same threshold. The curves suggest that measurements of surround luminance averaged for angular areas less than the full field would perhaps provide an even better basis for the prediction of threshold luminance.

The authors wish to emphasize that the data reported are based on measurements by two observers and therefore are not claimed to be those of a standard observer. Many more data for many observers and scenes would be required in order to establish a standard.

References

1. E. M. Lowry, "The luminance discrimination of the human eye," *Jour. SMPTE, 57:* 187–196, Sept. 1951.
2. E. M. Lowry, "Some experiments with binocular and monocular vision," *J. Opt. Soc. Am., 18:* 29–40, Jan. 1929.
3. L. A. Jones and H. R. Condit, "The brightness scale of exterior scenes and the computation of correct photographic exposure," *J. Opt. Soc. Am., 31:* 29–40, Nov. 1941.
4. W. D. Wright, *Researches on Normal and Defective Color Vision*, C. V. Mosby, St. Louis, Mo., 1947, pp. 230–231.
5. B. H. Crawford, "The effect of field size and pattern on the change of visual sensitivity with time," *Proc. Roy. Soc. London, 129B:* 94–106, June 1940.
6. C. A. P. Foxell and W. R. Stevens, "Measurements of visual acuity," *Brit. J. Ophthalmology*, pp. 513–533, Sept. 1955.

Discussion

K. B. Benson (Session Chairman): Did you make any investigation of the influence of color on these responses?

Mr. Lowry: No, that has not been done as yet, but it is a natural sequence.

Television as a Military Intelligence and Communications Medium

By NORMAN GRAY
and JAMES C. JANGARATHIS

The continuing need for a more efficient intelligence system in the modern Army is focusing attention on television as a basic means of communication. This paper summarizes some of the proposed applications for military television in combat, describes types of current iterim mobile television units, and presents recent maneuver utilization of two units.

One of the main differences between military and commercial television is the military requirement for a higher quality resultant for intelligence interpretation, even though the system may be operating under extremely adverse conditions. Military television as an immediate audio and visual means of communication between all echelons of command appears to be highly desirable; however several limiting requirements exist.

High equipment mobility and ruggedness are essential. Four requirements are of special importance:

1. Portability: Weight and size should be kept to a minimum. Complete TV camera chains and transmitters must be carried as easily by jeeps and in the same manner as army radios are carried.

2. Durability: The TV system must sustain treatment that is equivalent to that which other tactical military communications can endure.

3. Power consumption: The problem is to generate enough power with no sacrifice of portability.

4. Weather and fungus proofing: Equipment must operate efficiently under any climatic condition.

Two other considerations, protection against jamming and the method of propagation, must also be considered by the military.

The method of propagation has two extremes, the microwave-type consisting of a very narrow beam and a uniform distribution type having a 360° radiation pattern. Microwave propagation has a "line-of-sight" prerequisite that, with present equipment and facilities, is often impossible to obtain under fast tactical field conditions. When this prerequisite is obtained, however, distances of 25 miles may be realized. The strict "line-of-sight" requirements make cover and concealment difficult, since the reflecting parabolic dishes of the microwave systems must be above the surrounding vegetation. To obtain line-of-sight often requires towers of considerable size. Tower construction at the present time is time consuming and lends itself to a semi-fixed type of installation. New hydraulic telescoping towers may solve this mobility problem very shortly. Since microwave is highly directional, having a beam width of approximately 2.5°, and transmits in most tactical applications from forward areas toward rear echelons, the ability of the enemy to intercept these signals, while possible, is limited.

Semidirectional and uniform radiation patterns, moving toward the other end of the "methods of propagation" scale, do not require strict line-of-sight and can penetrate wooded terrain. The operating range of ground-to-ground transmission is, however, very limited, being 5 to 7 miles with present equipment. Telescoping antennas and high-power output transmitters are being investigated for increased range. One outstanding advantage of this method of propagation is the capability of transmitting on the move. This method is the one used by airborne TV pickup stations. A serious disadvantage is the fact that the enemy can intercept the signal without great effort on his part. Coded signals and preplanned orientation of pictorial information may combine to decrease this possible intelligence leak considerably.

Background of Army Television

In 1948, the Signal Corps contracted for the construction of the first Army mobile TV system. The tactical situations in which the original unit could be used were highly restricted because of its great size and weight.

In December 1952, steps were taken to obtain the first tactical-type unit. The mission of this unit was to study and evaluate the employment of television in tactical situations.

A requirement for high-quality kinescope recordings for training purposes and troop information also became apparent. The low-cost kinescope method of producing training and information films brought about the establishment of Studio F at the Army Pictorial Center, in 1952. This studio is equipped to record on 35mm black-and-white film. Quality closely approximating that of standard filmed productions is being attained.

The Army Pictorial Center is now investigating military field applications with field units.

Reconnaissance and Surveillance

It is axiomatic that a commander requires an accurate and timely estimate of the tactical situation to help him make the proper decision during combat. Television, properly used in tactical applications, can provide immediate visual information of critical areas and activities to the commander and his staff. Television systems mounted in light aircraft, in tanks, and in light trucks, are now being evaluated to determine the technical characteristics and utilization that is possible for each of these operations. Small planes equipped with TV cameras and transmitters can fly over areas about to be invaded, to furnish required information such as last-minute engineer reconnaissance of a critically located bridge. Television equipment mounted in jeeps and tanks can be attached to front line spearheading elements. This type of TV pickup station could transmit visual information of bridges, road blocks, general terrain features, captured equipment, etc., relaying to the commander an accurate pictorial description of selected portions of the front line situation.

Television equipment mounted in pilotless tanks may avoid traps into which our forces may fall and may enable the armored force commander to use the remotely controlled tanks as forward scouts, giving him immediate information. Immediate accurate data as to the results of bombing attacks or artillery preparations can be supplied to help ensure the most efficient use of our striking forces.

The control of artillery fire calls for accurate and continuous outpost information. During World War II, L-4 and L-5 observation planes frequently performed this mission, at times flying almost directly over the target area. This same fire control information can be obtained by pilotless planes (drones) which have TV equipment. Decisions can be made with greater speed and accuracy by army, corps, or division artillery commanders if they see for themselves an immediate action picture of the target area during the attack.

Message traffic, weather information, requisitions, and all other types of military communications must be relayed promptly and efficiently before and during combat actions.

A slow-scan vidicon TV system is

Presented on May 4, 1956, at the Society's Convention at New York by Lt Col Norman Gray (who read the paper) and Lt James C. Jangarathis, Army Pictorial Center, Television Div., 35-11 35th Ave., Long Island City 1, N.Y. (This paper was received on April 2, 1956.)

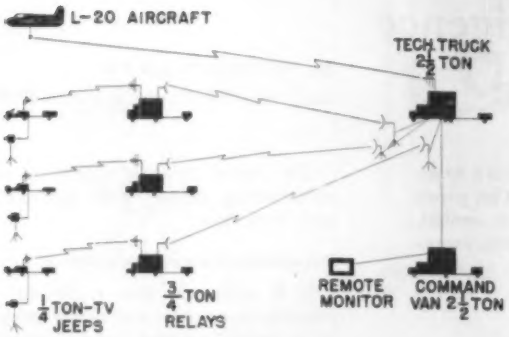


Fig. 1. Combat television system layout.

available, and being further improved, whereby duplicate copies of messages, photos, and all types of data information can be transmitted to a distant receiving site. The transmitting end of this system consists of a slow-scan vidicon camera, control equipment having a technical control monitor, and a transmitter. Since the bandwidth of the signal derived from the slow-scan camera chain is relatively narrow, 3–6 kc, the means of propagation can vary from microwave to existing radio and telephone conductors. The electrical impulses at the receiving end are converted to visual information on a specially designed picture tube having phosphors of high persistence. A 16mm camera chain focused on the picture tube provides a negative or positive print. From this, any number of enlarged positive prints may be made, or the film may be projected on a screen for rapid inspection.

The forward element transmitting equipment can be mounted in a jeep or similar vehicle for mobility.

The slow-scan vidicon pickup and kinescope receiving system is capable of more immediate transmission of greater quantities of written or photographic information than presently available conventional facsimile or teletype equipment.

Face-to-face conversations between commanders and subordinates in combat are often difficult due to considerations of time. Conferences accomplished through the medium of television will permit instantaneous transmission of verbal or written instruction, information about new or captured equipment, interrogation of prisoners of war, and exhibits of maps, diagrams or charts. With a properly set up TV system, each commander can remain at his command post while participating in a sound and sight briefing.

The applications discussed above are only a small part of the military television potential. As an intelligence medium the possibilities are almost unlimited. An example may be made of some of the activities of Pictorial Center military TV units.

River Crossing Demonstration

On 11 August 1954, the Army Signal Corps Interim Tactical Television Units, and the NBC and RCA Color Television Caravans gave a military TV demonstration at Fort George Meade, Md. The purpose was to demonstrate some of the potential applications and capabilities of a tactical TV communications system. The demonstration was designed around a regimental attack involving a river crossing, armored action, artillery support and air evacuation, and was planned to provide as many applications as possible for military TV coverage. This maneuver was covered by a more extensive tactical TV operation than had ever before been performed, making it possible to evaluate equipment and operating techniques under tactical conditions.

The three microwave signals from each of the ground cameras and an airborne signal were all received at a 2½-ton truck located at the command post. Each picture was displayed on a monitor in the truck for use in controlling the technical operation of the entire system. Each picture was also sent to a monitor at the command post for viewing by the military and civilian audience.

Aside from field characteristics of specific equipment used, certain fundamental requirements for tactical employment of TV were lacking in the Fort Meade maneuver. The immobility of the microwave systems, the elaborate and specific pre-planning for TV coverage, and the staged performance of the maneuver were fully realized; nevertheless, the value of the experience obtained, and the lessons learned, were inestimable. Ranking officers at the command post saw, for the first time, the enormous possibilities for obtaining intelligence by military TV covering a tactical action. The design of the most recently acquired military systems was advanced through experience gained during this maneuver.

Ground Combat

In July 1955, the Army Pictorial Center, Long Island City, N.Y. received a newly designed unit — a compact, mobile unit, designed to provide communications in field situations and under

Fig. 2. Light aircraft mounted televison pickup and transmitting station.

Fig. 3. Jeep-mounted television pickup and transmitting station.

field conditions. The design of this unit was a direct outgrowth of the experience derived from exercises similar to the river crossing briefly described above.

Maximum use of the unit provides a TV picture from each of four different locations (Fig. 1). Three of the pictures are from mobile ground units; and the fourth is a picture from a TV camera, mounted in a light aircraft (Fig. 2). The pictorial information from these four sources can be transmitted a maximum of 25 miles to a command viewing site. The unit can also record still pictures of a TV image. Figure 3 shows a jeep-mounted TV pickup station.

Each of the three jeeps carries an industrial-type TV camera which measures 4 × 6 × 8 in. and can be easily hand carried. Camera cable carried with each jeep will allow the cameraman to operate as far as 250 ft from his jeep. The small camera may also be mounted and operated from the jeep. A small TV transmitter is associated with each camera. The picture signal from the camera is fed into this transmitter and is broadcast a maximum of 1 to 5 miles (depending on terrain) to the relay truck assigned to that jeep.

At the relay truck, a receiver picks up the picture broadcast from the camera jeep and feeds the video signal into a microwave transmitter mounted on top of the truck. This microwave transmitter is beamed to a receiving antenna located near a technical van at the receiver site. Maximum distance between the relay van and the technical van varies, depending upon terrain features, up to 20 miles. This distance must be measured on a line-of-sight. The technical van receives microwave signals from all three relay vans.

The light aircraft (Beaver L-20) carries two airborne image-orthicon TV cameras. One is mounted in the "belly" of the aircraft. The other has a flexible mounting and is controlled by the cameraman who can move it within the limits of a port in the side of the aircraft. A signal, from either one of these cameras, is fed into a transmitter mounted in the aircraft. The airborne transmitter can broadcast the signal 10 to 25 miles to a receiver in the technical van. The technical van maintains technical control of the system and supplies video information from the four picture sources to the command van. The TV unit commander can control the entire operation from the command van. He has radio contact with all vehicles, cameraman and the aircraft, and is able to remotely control the selection of the desired pictures to be broadcast over the system at any given time. The command van is located as close as terrain features permit to the command post of the tactical commanding officer using the TV system. The command van is utilized for final viewing of the televised pictures. A specially designed still camera is available in the command van for recording pertinent visual information directly from the face of the receiver.

Exercise "Sagebrush"

The TV unit described above went through its first complete field test at "Exercise Sagebrush." This maneuver was of the "free" type, having two relatively equal opponents. The TV unit was attached to a division reconnaissance troop and its mission was to provide instantaneous visual coverage of the tactical situation for the commander and his staff. The unit was used to provide coverage of various tactical situations, both air-to-ground and ground-to-ground, including:

(1) Verification of non-visual information by means of supporting pictorial information.

(2) Location of friendly and aggressor units and emplacements, and the study of enemy activities.

(3) Study of terrain features.

(4) Transmission of pictures of captured enemy material.

As an illustration of how television was used during "Exercise Sagebrush," the following excerpts from TV missions are cited:

"17 Nov 55. The mission of running TV airborne road reconnaissance of the aggressor Army's main route of advance was assigned to the TV Section. Video was transmitted from the airborne pickup station to the command post receiving site. Video reception was acceptable and supplied information concerning road blocks, amount and type of traffic, tie-ups and general traffic conditions."

"19 Nov 55. Three TV jeeps were dispatched to key points along the main route of advance. Their primary mission was to televise pertinent information to the tactical commander. Vehicle and troop movements were televised, and particular attention was given to traffic bottlenecks and equipment failures or fatalities (umpire scoring). This operation illustrated that the maximum transmitting range of the video signal from the jeep over heavily wooded terrain was 1.5 and 2.0 miles."

"In conjunction with these activities, an air mission was very successful. This mission was to provide TV coverage along the main line of resistance. Airborne coverage enabled Division Advanced Headquarters to watch the operation of a mass movement of large vehicles behind a smoke screen. The coordinates of this movement were requested and obtained from the camera operator. In this operation, the Division G-2 (Intelligence Officer) had TV coverage of an area twenty miles forward of his position."

In general, the newest interim tactical unit accomplished its overall maneuver mission. The maneuver activities provided valuable information pertaining to utilization, special considerations, and definite limitations of presently available field TV equipment.

Television was used as an integral part of a combat unit. Actual conditions of war were simulated, and no "staged" type of demonstrations was included. This maneuver helped illustrate that television can be used for tactical employment.

Special considerations such as line-of-sight prerequisite for microwave propagation, maximum altitudes for airborne coverage, and cable limitations between jeeps and cameramen were still evident. Limitations were present, but the comparison between older television systems and the new unit was encouraging.

Existing problems were realized; some have been solved and new developments continue. The following list of recommended improvements is presented to illustrate some of the problems which confronted this TV unit:

(1) A more stable synchronization should be built into camera chains. Experienced personnel and commercial engineers have found that, under field conditions characterized by very high humidity, count-down synchronization controls require constant adjustment. Count-downs and blanking controls should be adjustable from the outside since normal working adjustments require removal of side panels, which is dangerous to personnel and equipment in inclement weather.

(2) A mixer should be added to the camera chains, with adjustment for synchronization and blanking levels, which would permit a composite video output signal, enabling direct cabling into relay vans. This would increase tactical capabilities during jamming by eliminating the broadcast feature of the system.

(3) Present UHF Yagi antenna is too fragile; a method for rapid rotation of the antenna and a system to vary its height are needed.

(4) A 110-v a-c operated, crystal controlled, average 100-w, 360-mc output transmitter is needed for increased jeep operating range.

(5) Utilization of a helicopter aircraft for reconnoitering microwave sites and transporting microwave relay equipment to locations not accessible to wheeled vehicles should be considered.

(6) A monitoring device for the pilot of the L-20 aircraft would increase efficiency of aerial coverage. A picture monitoring device available to the pilot would allow the pilot to see what his cameraman is shooting and make it possible for him to follow directions from the cameraman more quickly and efficiently.

Fig. 4. Man-pack television.

Most recent of the Army's television equipments is the Man-Pack "Television Unit" (Fig. 4), a light, compact combination of television chain, power unit, and transmitter. The camera weighs only 8 lb and the transmitter with built-in power supply, 47 lb. Four interchangeable lenses, including wide angle to view a broad sector, and telephoto for great distances, are available for diversified tactical employment. The transmitter has a half-mile to a mile range, and can operate continually for two hours off its five cell rechargeable battery. The receiver portion of the Man-Pack Television Unit may be jeep-mounted for mobility. This receiver has a 10-in. picture screen.

To minimize possible interception of the television signal, the camera can also be used with a cable between the transmitter and receiver. With power packaged within the transmitter, cable size is four times smaller than in earlier models. The greatest asset, however, of this unit is the capability it gives the cameraman to move over almost any type of terrain without being limited by accompanying cables.

Conclusions

Army tactical television is rapidly growing from the cumbersome studio-type equipments of just a few years ago, to the man-pack television pickup and transmitting stations of today. The participation of television units in varied type military applications is steadily increasing, thus providing much needed operational experience.

Since its infancy in 1948, Army television has illustrated an overall potential that is at least equal to other major intelligence and communications media. The ability to provide immediate visual information of critical areas many miles forward of the receiving site, gives the commander "Eyes" throughout his command, in our forward areas and in enemy installations. Application research, equipment improvement and development, and advanced training of military operating personnel are continuing in an endeavor to determine the ultimate military potential of television.

Discussion

Mauro Zambuto (Transound, Inc.): How much thought has been given to the two problems of interception and jamming?

Col. Gray: We have given this considerable thought. We have written papers on this and have, as recently as three months ago, submitted a paper on this very thing to Washington. It contains classified information; I am sorry that I can't discuss it at this particular time.

Edward Stanko (Radio Corp. of America): I noticed the difference in the quality between the types of kinerecording you have shown; on one section quite a few scanning lines were visible and on the other none could be seen.

Col. Gray: Each time we get a new emulsion we must run tests since the control of our kine is extremely critical in order to eliminate any shutter bar and also to eliminate the scanning lines. This particular stock we are using is Eastman stock. The emulsion was a little bit faster than the other emulsion that we had used. That is the reason for the difference in the quality in the particular portion of the kine. However, this was a test and not anything we would normally release.

Mr. Stanko: Do you intend to do a kinerecording of the original picture that you receive from the field?

Col. Gray: Yes, we do. We have two mobile units capable of kinerecording — one is at the Army Ballistic Missile Agency and the other is shortly going to Fort Rucker where they will make kinescope recordings in the field and integrate them with our studio activity. I hadn't felt until the last two or three months, that our kine quality was completely acceptable in the field; however, our studio work is acceptable now and nearly comparable to what can be achieved with regular motion-picture work. We did a kine at St. Albans, with one of the mobile units, of a medical conference, and this was the first acceptable quality from a mobile unit satisfactory for release. It approached the same quality of the segments you have seen here.

Anon: Do you use 35 or 16mm?

Col. Gray: We use both. The kine you saw this morning was 35. We made a master, a dupe negative and a contact print. What you saw was the contact. We also have 16mm kine that we use. This particular one was 35 but we do use 16 at our studios and in the field.

J. F. Fisher (Philco Corp.): In connection with slow-scan television, what type and size of primary image do you prefer to work with? And secondly, do you think a 2-sec frame-scanning rate and a 7½-kc bandwidth are adequate for most purposes?

Col. Gray: Well, actually I'd like to stay away from this particular question. Here in this paper I was exploring the utilization of a slow-scan system. We have not procured any of this equipment yet. There are two or three manufacturers that have these equipments and I'd rather not say what characteristics we require until we further explore available equipments. We are interested in equipment of this type but we would like to see what is best for the military service before we go into actual procurement.

An Audio Flutter Weighting Network

By FRANK A. COMERCI
and ELISEO OLIVEROS

Listener preference rankings of selected samples of programs containing many types of flutter will be compared to measurements of the same flutter using a meter weighted with respect to flutter rate in accordance with the threshold of perceptibility. It is shown that the correct weighting curve varies with the level of flutter and that modification should be made to the flutter meter in order to obtain objective rankings of various types of flutter which will agree with subjective rankings of program containing the same type of flutter.

In the processes of recording and reproducing sound, a serious distortion results from instantaneous relative speed variations between the respective transducer and the recording medium. This distortion, termed flutter, manifests itself as a frequency modulation of all the tones comprising the recorded program. It has long been recognized that the perceptibility of frequency modulation in tones is influenced to a significant extent by the flutter rate or the cyclic rate of variation of the transport medium speed.[1,2] An attempt was made a few years ago to incorporate a flutter index, in the form of flutter rate weighting formulae, in a standard method for measuring flutter[3] but the plan was dropped because of a lack of information relative to whether perceptibility thresholds for flutter in pure tones could be applied to the complex waveforms of speech and music programs. Subjective experiments conducted at the New York Material Laboratory for the Navy Bureau of Ships[4] indicated that the relative effect of flutter on music was similar to its effect on a 1000-c (c-cycles per second) tone and that, for complex flutter waveshapes, a measure of the root-mean-square deviation from the mean frequency would give an adequate indication of the combined effect of all the flutter components on a tone or program. It was concluded from these experiments that not only could the threshold of perceptibility for pure tones be used as a basis for applying flutter index formulae for programs but it could also be used as the basis for incorporating a flutter-rate weighting filter in flutter measuring instruments. The following considerations were advanced to support the use of a flutter index weighting filter:

(1) The predominant frequency components of speech and music program are between 500 and 5000 c where the effect of flutter is constant with tone frequency and most perceptible.

(2) The effect of flutter is constant and most perceptible over the range of probable program listening levels.

(3) Although the absolute perceptibility thresholds vary with the acoustic characteristics of listening areas and with the content of program for example, kinds of musical instruments, the relative effect of flutter rate is essentially the same. A flutter index measuring instrument should indicate the effect of a particular flutter on a program which is most susceptible to the effects of flutter and for conditions under which the flutter is most perceptible.

These experiments, demonstrated that the flutter thresholds for earphone listening to a 1000-c tone recorded on magnetic tape are approximately three times greater than those for ear listening to a 1000-c tone from a frequency modulated oscillator. Apparently this difference results from masking by an inherent flutter in the 1000-c recording or from noise and distortion products associated with it. Insofar as the weighting network is concerned, this difference is not troublesome, for the relative effect of flutter at various flutter rates from 0.5 to 100 c is essentially the same for the recorded and generator tones except for flutter rates below 1.5 c. Apparently the lower relative thresholds for the recorded tone were due to a better subjective technique or to the fact that the relative data for the recorded tone below 5-c flutter rates were actually obtained for loudspeaker listening. It is noted that the results at these lower flutter rates are in better agreement with thresholds obtained for loudspeaker listening in large auditoriums. In view of this, the inverse curve of that representing the average flutter perceptibility thresholds of recorded 1000-c tone, chord, piano music and orchestra music for flutter rates from 0.5 to 100 c was proposed for the flutter rate weighting network. A well damped root-mean-square indicating meter was proposed as an indicating meter.

The experiments reported here were conducted by the Material Laboratory for the Navy Bureau of Ships and represent an extension of the previous work. A flutter index meter was devised and flutter index measurements of many complex variations of flutter were compared with subjective quality rankings of three types of program containing the same flutter variations. Experiments were also conducted to determine whether any change in ranking was associated with various listening conditions.

Flutter Index Meter

An available flutter meter which contained a low-impedance output and which was originally designed for operating an oscillographic recorder was selected for modification to a flutter index meter. Measurements showed that the sensitivity of the low-impedance output circuit was constant over a flutter rate range from 0.5 to 200 c and was linear over this range for flutter amplitudes up to 2.8% peak. It could be converted into a flutter index meter simply by connecting a suitable weighting filter and indicating meter to this low-impedance output circuit. A standard VU meter was used as the indicating instrument instead of a thermocouple meter in order to have a standard damping characteristic.

There is reason to believe that the actual pitch heard by a listener is a function of the tone frequency over a time period of approximately 140 msec, for the ear ceases to hear a change in pitch when sinusoidal flutter rate is increased above about 5 to 7 c. The VU meter is similar in its damping for it ceases to register any amplitude modulation when the modulation rate exceeds about 7 c. Thus, the VU meter, in addition to providing a standard damping, also has a damping which is similar to that believed to be associated with the pitch sensitivity of the ear. Comparison of flutter readings obtained from the VU meter (rectified average over a standard time period) and a thermocouple meter (rms over a nonstandard time period) for the complex flutter waveshapes used in the experiments indicated that any differences were insignificant. The filter inserted between the flutter meter and the VU meter provided an overall sensitivity to constant flutter amplitude as shown in Fig. 1.

The design objective was determined from the average perceptibility thresholds for the four program samples of the previous experiments.[4] For the low flutter rates where the pointer of the VU meter tended to follow the flutter amplitude excursion rather than indicate an average, the average peak swing was taken as the reading. The amount of variation between the actual sensitivity curve and the design objective was not considered important in view of the variance anticipated for the subjective

Presented on May 3, 1956, at the Society's Convention at New York by Frank A. Comerci and Eliseo Oliveros (who read the paper), Acoustics and Interior Communications Sec., Material Laboratory, New York Naval Shipyard, Brooklyn 1, N.Y.
(This paper was received on April 3, 1956.)

quality rankings but was taken into account in analyzing results.

The sensitivity of the flutter index meter was adjusted so that readings on the per cent scale of the VU meter would agree with listener preference ranking scores that would be expected from a fluttered program. In particular, the sensitivity was adjusted so that the meter gave a reading of 100% for a flutter amplitude of 2% peak at a flutter rate of 3 c. This value of flutter was found in the previous experiments to just begin to cause saturation (approach a maximum ranking score) in a listener preference ranking vs. flutter amplitude curve.

Subjective Rankings

The ranking technique employed was the Listener Preference Ranking Test used in the previous experiment.[4] This test consisted of paired comparisons by a group of judges on program samples containing the variations of flutters to be compared. One of the flutter variations was used as a control standard of comparison to which all the others were compared and judged as being "much worse"—"worse"—"same"—"better" or "much better." A category of "don't know" was included to account for the possibility that because of inattentiveness or other similar reason the judge was unable to make a comparison.

The judgments for each group to be ranked, in this case each program, were then quantified for each judge, by assigning a number of rank to each judgment category for each judge. The quantification scheme was designed to provide an equal basis of comparison for each judge in a numerical form. The average number of rank assigned by the group of judges for a given flutter variation was then taken as its ranking score. The higher numbers were associated with the least preference or "much worse" quality.

Flutter Generation

Flutter variations were introduced into the program in two ways. One method employed the Material Laboratory Flutter Generator[4] which uses a magnetic head mounted to a loudspeaker cone to provide relative longitudinal motion between the head and a magnetic tape. The flutter generated in this manner was controlled by the signal fed to the loudspeaker voice coil.

The second method employed a high-quality tape recorder which has a low flutter content when operating with the flywheel removed from the tape-drive capstan. The desired flutter was introduced by varying the frequency of the power source used to power the synchronous driving motor. The power source was derived from a 50-w audio amplifier fed from a frequency-modulated 60-c oscillator. This system made it possible to duplicate reasonably flutter found in actual equipment by substituting for the 60-c oscillator, a fluttered signal from a 60-c recording as reproduced from the particular equipment.

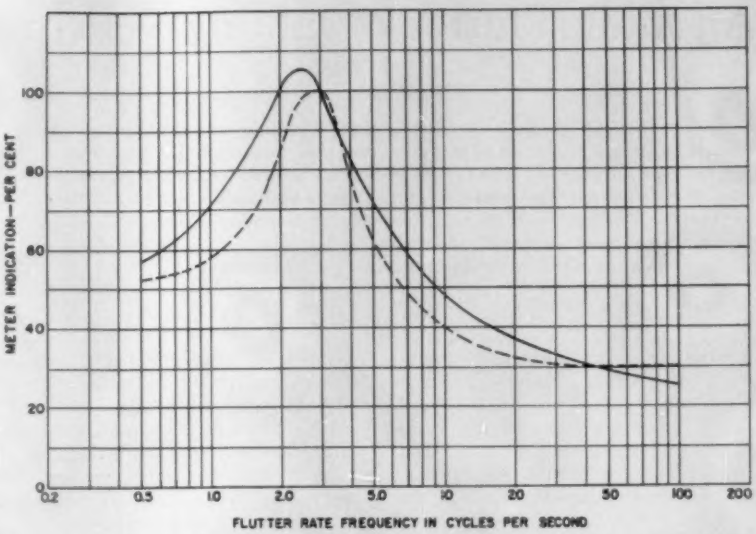


Fig. 1. Sensitivity vs. flutter rate for Material Laboratory Flutter Meter: input flutter 2.0% (peak); ———measured sensitivity; and – – – –design objective.

The first generator was not able to generate flutter rates below about 3 c while the latter was limited to flutter rates below 25 c. Therefore, the Material Laboratory Flutter Generator was used to generate flutter for one listener preference test in which the flutter variations consisted primarily of high-frequency flutter rates above 5 c, while the modified recorder was used to generate flutter for another listener preference test in which the flutter variations were confined to flutter rates below 25 c. Two tests were employed to eliminate the possibility that the comparisons might be influenced by differences other than flutter existing between the two generators.

In Listener Preference Test I, samples of the following program material were selected from magnetic tape recordings of local FM broadcasts:

(1) A 10-sec sample of a piano rendition of a popular melody "You'll Never Know." The sample was taken from a part containing both short and sustained notes including both high and low pitches.

(2) A 10-sec sample of a military band playing "Tales of the Vienna Woods." The sample consisted of clarinets and brass instruments and had several sustained chords.

(3) A 10-sec sample of a male news commentator.

To generate flutter, these samples together with a 20-sec sample of a 3000-c tone, which was recorded on a tape using the same recorder used to record the program, were spliced together at the center of a 1200-ft reel of tape. They were played back on the Material Laboratory Flutter Generator which was used to introduce 30 flutter variations. These were recorded on another recorder to obtain samples of fluttered program for use in the subjective tests and samples of fluttered tone for use in obtaining flutter index measurements. Since the sample of 3000-c tone had been subjected sequentially to the same recording and reproducing processes as the program, the flutter in these samples was the equivalent of that introduced in the program. Flutter oscillograms obtained from the tone samples (Fig. 2) indicate the complexity and range of the 30 flutter variations compared in the test. These variations were selected at random to give a representative sampling of flutter rates from 4 to 100 c and amplitudes which promised to provide a range from nonperceptible to the maximum of perceptibility. The program samples were spliced together to permit "A—B" comparisons between each flutter variation and the control standard of comparison for each program. Program randomization was not employed and for each comparison the standard was presented first.

In Listener Preference Test II flutter comparison tapes were obtained in a manner similar to that of Test I except for the difference in flutter generation. The program selections were:

(1) "Viola and Piano Sonata in F Minor" by Rubenstein. A 10-sec passage was selected in which the piano predominated with rich chords and a fast group of short single notes as well as sustained notes at a reasonably high pitch.

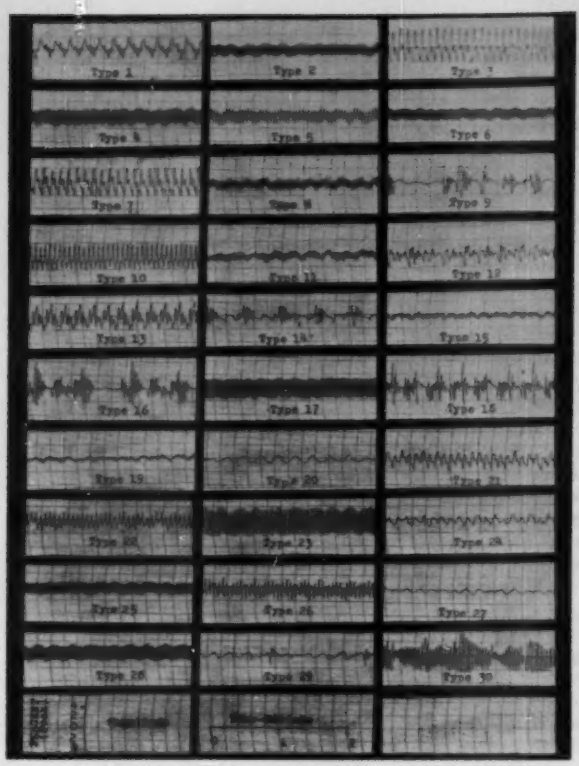


Fig. 2. Oscillograms for flutter variations used in Listener Preference Test I.

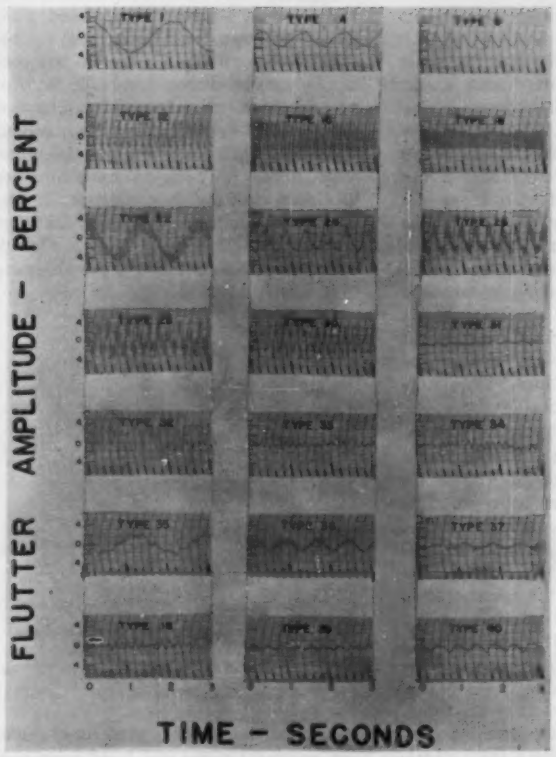


Fig. 3. Oscillograms for more complex flutter variations used in Listener Preference Test II.

Table I. Flutter Index Measurements and Listener Preference Ranking Scores for Listener Preference Test I.

Flutter variation No.	Flutter measurement		Listener preference ranking scores %(max. score)			
	Peak-to-peak flutter, %	Flutter index	Piano	Band	Speech	Av. Piano & band
1	4.0	55	59	41	20	50
2	2.5	55	61	59	38	60
3	6.2	67	100	97	89	98
4	3.5	49	75	83	70	79
5	3.0	49	62	77	66	70
6	2.7	57	51	56	60	54
7	5.6	84	82	97	89	90
8	2.4	52	51	55	59	53
9	5.7	43	63	57	45	60
10	5.0	55	86	88	84	87
11	2.5	31	49	44	50	47
12	4.0	52	44	59	34	52
13	5.0	61	66	86	60	76
14	4.0	39	32	48	36	40
15	1.5	25	28	22	25	25
16	8.5	55	85	76	60	81
17	4.4	58	62	74	87	68
18	8.0	58	65	71	82	68
19	1.2	23	25	19	25	22
20	1.8	41	12	9	22	11
21	3.5	54	33	42	39	38
22	3.6	47	48	59	59	54
23	5.5	61	93	97	100	95
24	2.7	38	29	27	30	28
25	2.7	25	53	40	57	47
26	3.7	43	41	50	69	46
27	1.0	26	20	14	15	17
28	3.3	54	69	85	84	77
29	3.5	26	34	23	26	29
30	7.5	58	91	100	87	96

Table II. Flutter Index Measurements and Listener Preference Ranking Scores for Listener Preference Test II.

Flutter variation No.	Flutter measurement			Listener preference ranking scores (% max. score)			
	Peak-to-peak flutter, %	Flutter rate, c	Flutter index	Piano	Band	Speech	Av. band & piano
1	6.6	0.5	90	93	93	39	93
2	7.6	0.5	97.5	89	94	47	92
3	2.0	0.75	31	65	19	39	42
4	3.0	1	55	43	47	47	45
5	7.6	1	100	97	100	48	99
6	4.6	1.5	97	93	88	33	91
7	2.6	2	55	36	54	47	45
8	3.0	3	60	43	44	49	44
9	4.4	3	85	87	86	53	87
10	6.0	4	87	91	100	52	96
11	1.6	6	20	39	34	41	37
12	5.4	6	55	98	98	44	98
13	0.8	8	10	26	23	44	25
14	1.5	10	18	35	28	38	32
15	2.4	5	32	39	41	34	40
16	5.6	10	45	88	92	84	90
17	7.0	15	48	100	100	100	100
18	3.6	20	32	64	83	69	74
19	5.6	20	40	77	99	86	88
20	5.3	25	36.5	93	90	87	92
21	8.6	0.5	95	100	100	92	100
	4	12					
22	6.0	0.75	96	87	98	73	93
	2.0	27					
23	1.0	1	20	32	27	35	30
	0.3	12					
24	3.6	2	90	57	78	49	68
	2.0	9					
25	2.6	2	75	74	44	44	59
	0.8	24					
26	4.0	3	88	86	89	54	88
	2.0	24					
27	1.0	4	20	34	33	32	34
	0.5	21					
28	4.4	4	68	94	95	62	95
	3.0	18					
29	3.4	5	43	75	73	58	74
	1.4	18					
30	4.8	6	56	98	83	65	91
	2.0	15					
31	...	...	10	35	32	43	34
32	...	...	55	90	94	84	92
33	...	...	35	39	54	46	47
34	...	...	25	25	39	46	32
35	...	...	60	53	59	46	56
36	...	...	45	46	43	41	45
37	...	...	25	21	27	47	24
38	...	...	28	37	44	31	41
39	...	...	25	30	25	49	28
40	...	...	40	31	25	31	28

(2) A military band playing "Under the Double Eagle," a march. A 10-sec passage was selected which contained woodwind and brass instruments.

(3) A 10-sec sample of a male news commentator.

This test consisted of comparisons of 40 flutter variations. Twenty of these had single flutter rates selected over a flutter rate range from 0.5 to 25 c with amplitudes chosen at random to provide equal predicted increments of quality. Ten were selected to contain a combination of high- and low-frequency flutter rates with amplitudes which were predicted to provide equal increments of quality. The remaining ten were representative of actual motion-picture projector, disk playback and tape recording equipment. The particular flutter variations are indicated in Table II and oscillograms for several appear in Fig. 3. The samples of fluttered program, when spliced to permit comparisons, were arranged in a statistically random fashion with respect to type of program, flutter variation and presentation of standard first.

Listener Preference Tests

For the Listener Tests, 18 judges, all male and ranging in age from 23 to 40 years, were seated fairly comfortably in an acoustically soft listening room about 100 ft long, 20 ft wide and 10 ft high. Each judge had had previous experience in comparing fluttered programs. The walls and ceiling of the room were polycylindrical and covered with acoustic tile. The floor was rug-covered concrete. The reverberation time was approximately 0.25 sec at 1000 c and the ambient noise level was about 60 db, consisting of predominantly low-frequency machinery rumble. This listening condition will be referred to later as "Condition A."

The program comparison tapes were reproduced and projected through a triaxial loudspeaker system which was centrally located in front of a perforated motion-picture screen hanging about 15 ft from one end of the room. The judges were grouped close together about 20 ft from the loudspeaker on its axis along the length of the room. The peak program level at the judges' positions was about 90 db (ref. 0.0002 microbars).

The response of the overall system from initial program recording through the various recording and reproducing processes and flutter generation to final presentation to the judges was essentially that of the loudspeaker. Its response was uniform within ±5 db from 200 to 10,000 c and decreased gradually below 200 c by approximately 6 db per octave and above 10,000 c by about 12 db per octave giving what should be considered adequate response from 40 to 15,000 c. The harmonic distortion of the system for sinusoidal signals from 100 c to 10,000 c and amplitude representing the amplitude of program peaks was less than 1.5% peak. The signal-to-noise ratio excluding the ambient noise in the room was about 45 db. Inherent flutter was about 0.3% peak at a flutter rate of 6 c. Inherent amplitude variations in the order of approximately 4% peak were introduced by the magnetic tape recording processes and were random in nature. Any amplitude variation which might have been caused by the flutter generators could not be detected in the electrical signal.

In order to guard against listener fatigue, the judges were asked to provide no more than 50 comparisons at a single seating and no more than three seatings were usually undertaken during the morning from about 9:00 A.M. to 11:30 A.M. Before presentation of comparisons the judges were told that they were to compare the two selections on the basis of preferred quality and not to attempt to assess the technical differences in the programs. They were given samples of the range of quality on which their judgments would be made.

Procedures

Listener Performance Ranking scores were obtained for each of the three programs for each experiment. Results were expressed in per cent of the maximum score obtained.

The ranking scores thus obtained were compared to flutter index measurements obtained from the samples of 3000-c tone.

The results of the above comparison indicated that the flutter index meter required certain modifications. These will be explained later. These modifications were made and the ranking scores were then compared to flutter index measurements obtained with the modified flutter index meter.

To ascertain whether various conditions of listening might affect the listener preference ranking scores and hence the usefulness of the flutter index meter, Listener Preference Test II was repeated with 12 judges for the following different room conditions, frequency-response ranges and sound levels:

(*1*) *Condition B:* The judges were seated in a diffuse reverberation chamber. This chamber had polycylindrical walls and ceiling of poured concrete. The floor was also poured concrete but flat. The chamber was approximately 20 ft long, 20 ft wide and 10 ft high. In the absence of the judges, the reverberation time was approximately 8 sec at 100 c and 5 sec at 1000 c. The triaxial loudspeaker was located in one corner of the chamber while the judges were seated close together in the center of the room. Peak program level at the listening position was about 90 db (ref. 0.0002 microbars). The ambient noise was approximately 60 db.

(2) *Condition C:* The judges were seated in a small acoustic listening room. This room had flat brick surfaces on which were hung removable panels of acoustic tile randomly spaced over the surface. The floor was covered with a rug. The room was approximately 20 ft long, 15 ft wide and 12 ft high. The reverberation time of this room was about 0.5 sec at 1000 c. The triaxial loudspeaker was located in one corner of the room while the judges were seated in an opposite corner. The peak program level was again approximately 90 db while the ambient noise was about 60 db.

(3) *Condition D:* Same acoustic conditions as "C" but the frequency response of the system was restricted by sharp cutoff filters to the range 300 to 3000 c.

(4) *Condition E:* Same acoustic conditions as "C" but the peak program level was reduced to about 80 db.

(*5*) *Condition F:* The judges were presented the program at a level of 60 db through high-quality earphones having a range from about 40 to 8000 c.

Results

The flutter index measurements and listener preference ranking scores for the 30 flutter variations used in Listener Preference Test I are shown in Table I along with peak-to-peak flutter readings which were determined from flutter oscillograms for each flutter variation. The ranking scores for the band and piano program were observed to be sufficiently similar to warrant the use of an average preference score for the two programs for the purpose of comparing the rankings to a flutter measurement. Usually the listener preference test gives a ranking for only those items compared in a single test and it is improper to use the scores obtained from one test for comparison with another test. It should be stressed that in this test paired com-

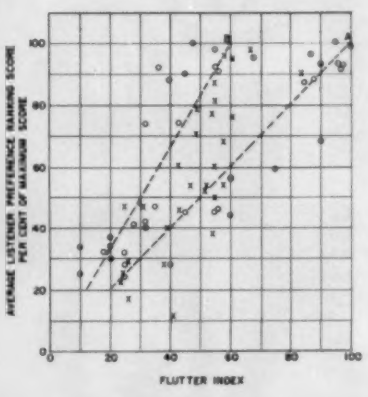


Fig. 4. Average listener preference ranking scores for piano and band programs vs. flutter index; includes data from Listener Preference Tests I and II.

parisons were made only between two flutter variations of the same program material and numerical ranking was assigned separately for each program. A comparison of one variation of flutter in one program with the same or different variation of flutter in another program was not made. Hence, it is improper to assume that the flutter variations had the same effect on the piano as it had on the band program. It can only be said that the rankings were similar or that if piano music containing one type of flutter sounded worse than piano music containing another flutter, then band programs containing the former flutter would sound equally worse than band music containing the latter flutter. As expected, comparison of the ranking scores with the peak-to-peak flutter measurements shows that little relationship exists between them. An appreciable relationship between the listener preference ranking scores and the flutter index measurements did exist.

The flutter index measurements and listener preference ranking scores for the 40 flutter variations used in Listener Preference Test II are shown in Table II along with peak-to-peak flutter readings which were determined from the flutter oscillograms. Here again, because of similar ranking scores for piano and band programs, their average ranking score is listed. Again, little relationship exists between the ranking scores and peak-to-peak flutter but an appreciable relationship exists between these scores and the flutter index measurements.

When the average preference scores for piano and band were plotted against flutter index readings for each test it was noted that the points seemed to indicate two straight-line relationships, one for low flutter rates and another for high flutter rates, shown as A and B, respectively, in Fig. 4. When the listener preference ranking scores for speech were plotted against flutter index the same two straight-line relationships were indicated. However, in the case of speech there was a scattering of points on that side of the lines which signified good quality but an excessive flutter index. This was expected, for it was known that large amounts of flutter at flutter rates below 5 c could not be detected in speech. The weighting curve used in the flutter meter was considered applicable to music only but it was felt that it could also be applied to speech since any resulting flutter index measurement would always be on the safe side.

On examining the two straight-line relationships it was noted that practically all of the points indicating the line B on Fig. 4 were associated with a flutter rate between approximately 10 and 25 c and amplitudes greater than 1% peak. This was thought to be due either to the particular room acoustics under which the listener preference tests were performed or to a nonlinearity in the relationship between the effect of flutter and its amplitude for this flutter rate range. Further experiments showed that the room acoustics, at least for the recorded program used, had only a minor effect on the results of the listener preference tests. Therefore, the discrepancy was attributed to nonlinearity. In the previous work[4] there was a linear relationship between the listener preference scores and flutter at rates from 0.5 to 5 c, and so it was assumed that this linearity would extend to all flutter rates. It is conceivable that in detecting flutter at flutter rates above 10 c, human factors differing from those used at flutter rates below 7 c come into play.

To correct for the above would require a new extended experiment to determine the exact relationships existing between the flutter perception and amplitude for various listening conditions. However, as an immediate means for obtaining a realistic measurement of flutter, a simple expedient was considered. As mentioned, the excessive ranking scores, or more accurately stated, the low flutter index readings, occurred only when the flutter exceeded 1%. It would then be necessary only to measure the average unweighted flutter for flutter rates above about 10 c. If the 1% peak level (0.7% rms level) were not exceeded, then the flutter index meter having the weighting curve of Fig. 1 would be satisfactory. If the 1% level were exceeded, then the weighting curve would have to be modified. Fortunately, in Listener Preference Test II enough sinusoidal flutters of known amplitude were included to permit an adequate estimate of the proper modification to the weighting curve.

A flutter index meter was subsequently designed which incorporated the two weighting networks with an automatic electronically operated switch. The two weighting curves employed are shown in Fig. 5. Curve A represents the active weighting characteristic for the switch open position. Curve B represents the active weighting characteristic for the switch closed position. The operation of the automatic switch is controlled by the unweighted flutter signal (Fig. 6). The switch actuating circuit operates on a rise time-constant of 0.1 sec and a decay time-constant of 0.25 sec.

Flutter index readings obtained with this modified flutter index meter for the flutter variations of both listener preference tests are compared with the average listener preference ranking scores for piano and band in Fig. 7. The flutter index measurements are tabulated in Table III. The relationship is considerably improved. The relationship for speech was similarly improved.

The piano and band ranking scores of the flutter variations used in Listener Preference Test II for the six types of listening conditions are listed in Table IV to show that the differences in listening conditions had small effect on the subjective ranking.

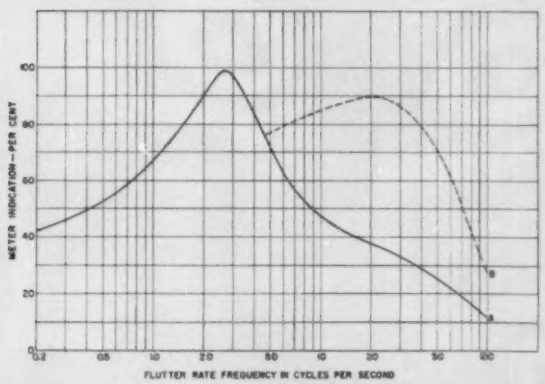


Fig. 5. Sensitivity vs. flutter rate for Material Laboratory Modified Flutter Index Meter: input flutter 2.0% (peak); Curve A — sensitivity for switch open position; and Curve B — sensitivity for switch closed position.

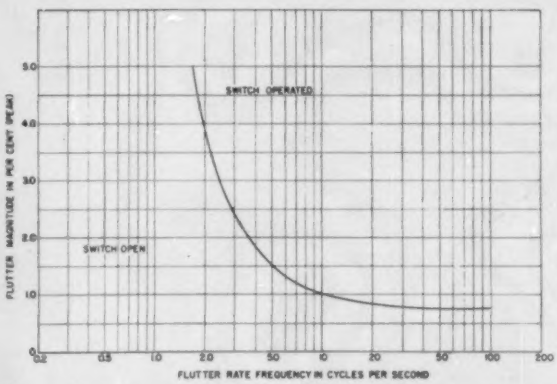


Fig. 6. Operating characteristic for automatic electronic switch of Material Laboratory Modified Flutter Index Meter: switch actuating circuit rise-time constant, 0.1 sec; and switch actuating circuit decay-time constant, 0.25 sec.

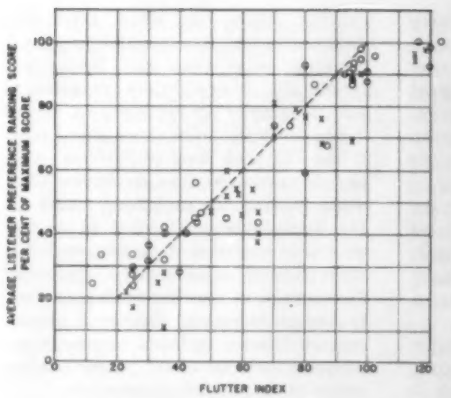


Fig. 7. Average listener preference ranking scores for piano and band program vs. Modified Flutter Index; includes data from Listener Preference Tests I and II.

Table III. Flutter Index Readings Obtained With Modified Weighting Network for Experiments I and II.

Experiment	Flutter type	Flutter index	Flutter type	Flutter index
I	1	...	16	70
	2	...	17	95
	3	120	18	85
	4	77	19	23
	5	70	20	35
	6	58	21	65
	7	98	22	63
	8	59	23	115
	9	55	24	35
	10	95	25	65
	11	50	26	60
	12	55	27	25
	13	85	28	80
	14	65	29	25
	15	33	30	115
II	1	80	21	130+
	2	95	22	120
	3	35	23	25
	4	45	24	87
	5	120	25	80
	6	100	26	100
	7	55	27	25
	8	65	28	98
	9	95	29	70
	10	102	30	94
	11	30	31	15
	12	98	32	95
	13	12	33	48
	14	30	34	35
	15	42	35	45
	16	93	36	45
	17	116	37	25
	18	75	38	35
	19	95	39	25
	20	83	40	40

Conclusions

A flutter index meter having the characteristics of the modified flutter meter used in these experiments will provide a reading that will adequately predict the subjective ranking score which would be obtained were that flutter introduced in a program sample and included in a similar Listener Preference Test. Such a meter would provide a simple objective measure of the effect of flutter on program material.

Discussion

The various types of flutter employed in this experiment were representative of all the amplitudes and waveforms encountered in actual recording equipment over flutter rates from 0.5 to 100 c. It might be expected that flutter rates above 100 c might be encountered. Recently, flutter rates as high as 3000 c are being observed in magnetic tape recorders. In view of this, it would have been interesting to extend the experiments to these flutter rates. Unfortunately, the flutter generators available could not produce adequate flutter amplitudes above flutter rates of 100 c. Besides, previous observations indicated that judgments of flutter perceptibility in programs for this range were erratic. It has been shown[5] that in the range above flutter rates of 100 c flutter perceptibility thresholds for tone can be used to predict the masking curves for the ear. It would appear, therefore, that perceptibility of flutter for such rates would be alien to the perceptibility of noise and could be included in a noise measurement (noise behind the signal).

It should be noted that in a few of the flutter variations the peak flutter amplitude varied periodically with time; for example, types 9 and 16 in Fig. 2. For this type of variation, the effect on the listener seemed to be connected with the average amplitude of the flutter over about a 2-sec time period. It also seemed to be a function of how the large amplitude periods coincided with the program peaks. Since, in obtaining flutter index readings, the average peak swing of the indicating instrument was used to indicate the flutter index, the flutter index readings tended to be too high relative to the corresponding listener preference scored. Such a reading applies a margin of safety for that type of flutter.

In a recent British publication,[6] a flutter meter with a peak indicator and a flutter weighting network which peaks at flutter rates between 5 and 10 c was proposed for obtaining realistic flutter measurements. This contradicts the results of the experiments reported herein. Another flutter meter was built using the

Table IV. Comparison of Listener Preference Ranking Scores for Various Listening Conditions.

	Listening conditions												
	A		B		C		D		E		F		All list.
No.	Piano	Band	Piano	Band	Piano	Band	Piano	Band	Piano	Band	Piano	Band	cond. av.
1	93	93	95	97	92	100	100	100	92	89	94	100	95.4
2	89	94	94	94	96	97	100	97	100	98	96	99	96.2
3	65	19	55	28	40	19	43	19	52	21	46	24	36.0
4	43	47	55	54	57	50	73	48	56	56	64	59	55.2
5	97	100	83	94	100	100	100	100	100	100	100	100	97.8
6	93	88	100	97	100	100	96	100	100	97	93	95	96.6
7	36	54	54	49	28	46	31	57	40	50	36	49	44.2
8	43	44	48	41	49	38	47	42	61	43	30	44	44.2
9	87	86	96	81	89	86	100	94	96	85	90	82	88.5
10	91	100	91	93	100	100	100	100	98	100	88	100	96.8
11	39	34	39	25	29	25	39	32	40	25	31	30	32.3
12	98	98	100	100	100	100	100	100	100	100	92	100	99.0
13	26	23	28	23	29	27	30	26	21	24	34	26	26.4
14	35	28	29	26	18	26	29	33	33	31	33	30	29.3
15	39	41	62	55	44	51	44	36	43	57	42	39	46.1
16	88	92	98	84	100	100	100	97	100	100	85	97	95.1
17	100	100	96	93	100	100	100	100	96	100	100	100	98.8
18	64	83	71	79	82	81	98	95	92	89	42	68	78.7
19	77	99	87	96	100	97	100	100	94	100	68	91	92.4
20	93	90	96	77	98	91	96	93	95	93	79	83	90.3
21	100	100	100	100	100	100	100	100	100	100	100	100	100.0
22	87	98	92	87	94	100	100	100	100	97	80	97	94.3
23	32	27	27	30	22	24	29	27	19	30	31	37	27.9
24	57	78	78	76	66	83	69	90	91	83	69	83	76.9
25	74	44	92	63	84	52	100	60	91	41	80	39	68.3
26	86	89	88	92	97	96	100	100	100	100	74	95	93.1
27	34	33	35	33	32	31	30	31	34	25	38	31	32.3
28	94	95	100	90	100	100	100	100	100	100	90	96	97.1
29	75	73	96	77	83	82	100	83	87	83	54	73	80.5
30	98	83	100	81	92	91	100	89	100	92	79	86	90.9
31	35	32	28	31	43	24	37	24	38	20	48	24	32.0
32	90	94	100	86	96	100	95	100	92	100	95	90	94.8
33	39	54	36	48	33	56	35	52	39	49	29	44	42.8
34	25	39	26	36	25	36	17	30	21	26	27	30	28.2
35	53	59	36	46	63	59	56	59	55	64	54	65	55.8
36	46	43	84	43	50	39	56	42	52	40	63	40	49.8
37	21	27	25	31	25	32	17	31	22	24	30	30	26.3
38	37	44	44	39	28	26	32	32	33	28	28	31	34.3
39	30	25	29	27	44	29	26	28	27	26	34	26	29.3
40	31	25	41	32	30	18	34	30	25	24	33	26	29.1

above proposed weighting network. An oscillographic recorder was used as an indicator from which the peak weighted amplitudes for all of the flutter variations of Listener Preference Test II were obtained. The corresponding ranking scores were compared with these readings but little correlation was obtained. Most of the variations appeared to be due to the different weighting network but it was felt that some also resulted from the use of a peak indicator. A concrete explanation for the contradiction cannot be advanced at this time but it is expected that this will be the subject of another paper.

In order to compare the results of the present experiments with those of the previous experiments,[4] the listener preference ranking scores of the latter for flutter rates from 0.5 to 5 c and amplitudes up to 5% peak were replotted in the form of equal ranking score contours as shown by the solid lines of Fig. 8. Forty-three of the 70 flutter variations employed in the present experiments were plotted on this curve and the appropriate ranking scores obtained indicated in circles. The remainder of the 70 flutter variations were not included since they either duplicated observations that are shown or their amplitudes and rates could not be determined adequately. The ranking scores, indicated at the plotted observations, are related to the contour lines. It should be noted that most of the ranking scores between 25 and 30% fall on or below the threshold curve, all the ranking scores of about 33% fall near the LP-30 line, etc., until all ranking scores between 80 and 100% fall above the LP-80 contour line. This shows agreement between the previous and present experiments. The dotted lines on this figure represent an extension of the equal ranking score contours to flutter rates above 5 c as estimated from the results of the present experiment. These extended contours, by their squeezing together above 10 c, suggest the nonlinearity experienced for the flutter rates between 10 and 25 c. It is obvious that further experiments are required to obtain an adequate measure of this nonlinearity.

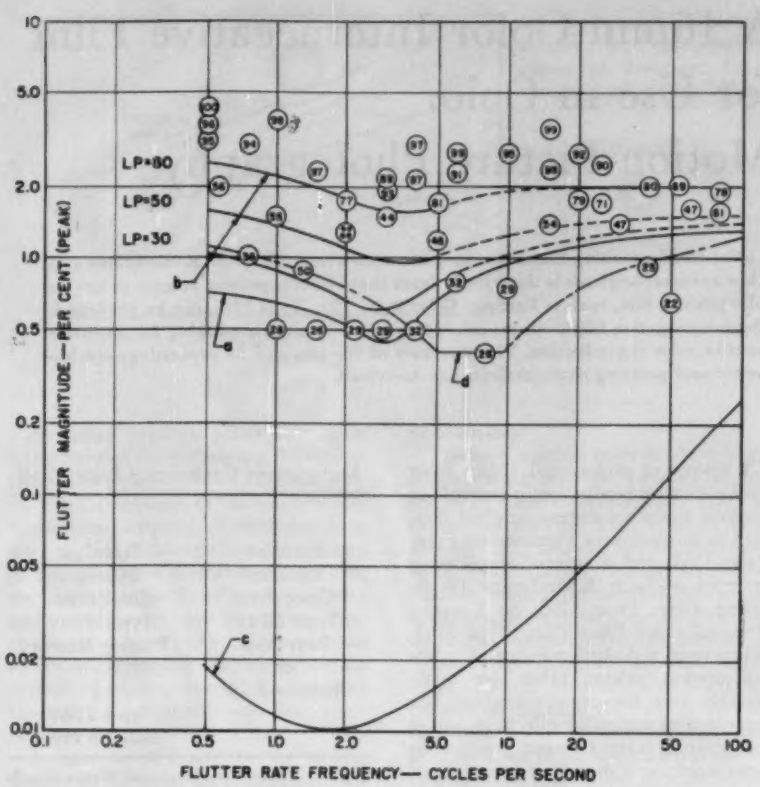


Fig. 8. Comparison of listener preference ranking scores with results of previous experiments.

a. Material laboratory flutter perceptibility threshold for piano.
b. Contour lines for equal listener preference ranking scores.
c. Flutter perceptibility threshold for pure tone (Bell Laboratories Reverberant Auditorium).
d. Stott and Axon flutter perceptibility threshold for piano.[6]

References

1. E. G. Shower and R. Biddulph, "Differential pitch sensitivity of the ear," *Jour. Acoust. Soc. Am., 3:* 275–287, Oct. 1931.
2. W. J. Albersheim and D. Mackenzie, "Analysis of sound film drives," *Jour. SMPE, 37:* 452–479, Nov. 1941.
3. SMPE Committee on Sound, "Proposed standard specifications for flutter or wow as related in sound records," *Jour. SMPE, 49:* 147–159, Nov. 1947.
4. F. A. Comerci, "Perceptibility of flutter in speech and music," *Jour. SMPTE, 64:* 117–122, Mar. 1955.
5. H. Schecter, "Perceptibility of frequency modulation in pure tones," *Doctoral Thesis,* Mass. Inst. Tech., 1949.
6. A. Stott and P. E. Axon, "The subjective discrimination of pitch and amplitude fluctuations in recording systems," *Proc. I.E.E.*, Paper No. 1874R, Sept. 1955.

A 16mm Color Internegative Film for Use in Color Motion-Picture Photography

By D. M. ZWICK, H. J. BELLO and C. E. OSBORNE

A color film for making 16mm motion-picture internegatives from Kodachrome and other reversal originals is described. From these internegatives, release prints on color positive film, such as Eastman Color Print Film, Type 7382, can be produced. The internegative film contains colored couplers to provide masking for improvement in color reproduction. The structure of the film and its processing, sensitometric and printing characteristics are described.

A system of professional 16mm color motion-picture production in general use involves a reversal camera original film, such as Kodachrome Commercial Film, Type 5268, and a reversal duplicating material, such as Kodachrome Duplicating Film, Type 5265, or Eastman Reversal Color Print Film, Type 5269. When only a limited number of prints are needed, release prints are made directly from the camera original. For lap dissolves and other effects, A and B roll printing is the common practice. In cases requiring high-volume release printing, an intermediate reversal printing master is often prepared on either the camera or the duplicating films, from which the final prints can be easily made on the Kodachrome Duplicating Film. Rush or work prints from camera originals are available on the color duplicating film. These printing methods are shown schematically in Fig. 1.

This system has the advantage that all stages involve reversal positives which allow visual evaluation of pictures for exposure and color balance. Furthermore, dust or dirt on the films will appear as black specks, which are less objectionable than white spots on final prints.

Disadvantages of the system are the degradation of color and tone qualities at each stage unless difficult and expensive masking methods are used; the higher cost of A and B roll release printing; and the complexity of processing the release print stock, which adds to the cost of each print.

An alternative system for high-volume print production requires a color internegative stage and a color positive release-print material, as shown in Fig. 2. The printing master is made from the Kodachrome Commercial Film camera original onto a color internegative film, from which multiple release prints can be economically and quickly made on a positive-type color print film, such as Eastman Color Print Film, Type 7382. With an internegative film containing color masks, the quality of the release prints can be quite high. Rush or work prints would be made on reversal materials, as is now done.

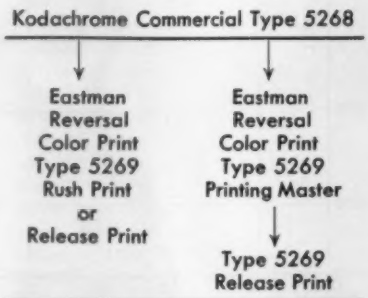

Kodachrome Commercial Type 5268
Eastman Reversal Color Print Type 5269 Rush Print or Release Print
Eastman Reversal Color Print Type 5269 Printing Master
Type 5269 Release Print

Fig. 1. Present professional 16mm duplicating system.

This paper describes a new color internegative film for use as a printing master between color reversal originals and positive-type color release-print films.

General Description

The internegative film, called Eastman Color Internegative Film, Type 7270, is an incorporated-coupler type, multilayer material. The structure is shown schematically in Fig. 3. The three color records are provided by emulsion layers sensitized to blue, green and red light, respectively, coated on a safety-film support. A yellow filter layer between the blue- and the green-sensitive layers prevents blue light from reaching the bottom layers. A removable antihalation layer is on the opposite side of the support. The emulsion layers contain, in addition to silver halide, coupler dispersions from which a cyan dye is produced, during processing, in the red-sensitive layer, a magenta dye is produced in the green-sensitive layer, and a yellow dye is formed in the blue-sensitive layer.

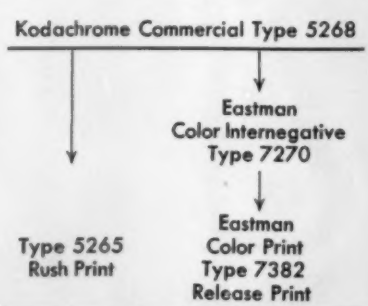

Kodachrome Commercial Type 5268
Eastman Color Internegative Type 7270
Type 5265 Rush Print
Eastman Color Print Type 7382 Release Print

Fig. 2. Proposed professional 16mm duplicating system.

As is the case with Eastman Color Negative Film, Type 5248,[1] two of the couplers employed in the internegative film are themselves colored before processing. The color of each of these colored couplers is discharged during processing in proportion to the amount of image dye formed, and the residual colored coupler serves as a mask to provide color correction for unwanted absorption of the image dye. The characteristics of these colored couplers are similar to those which have been described previously,[2,3] but have been adjusted so far as possible to fit the particular masking requirements of the proposed system.

In addition to image-forming agents, the emulsion layers contain soluble dyes which serve to reduce the scattering of light within the film during exposure, and thus help to provide a sharper image. These dyes give the unprocessed film a purplish color which disappears during processing.

Film Characteristics

Eastman Color Internegative Film, Type 7270, is a slow, fine-grain, long-latitude, color negative film balanced for tungsten-light sources as commonly

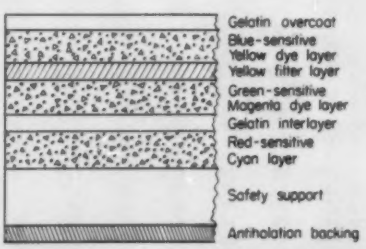


Fig. 3. Schematic cross-section of Eastman Color Internegative Film, Type 7270. (All layers contain a purple dye.)

Communication No. 1794 from the Kodak Research Laboratories, presented on April 30, 1956, at the Society's Convention at New York by D. M. Zwick (who read the paper), H. J. Bello and C. E. Osborne, Research Laboratories, Eastman Kodak Co., Rochester 4, N.Y.
(This paper was received on June 22, 1956.)

found in motion-picture printers. The useful latitude of the internegative film is sufficient to record a brightness range of 125 to 1, or a density range of 2.1 units, adequate to record the density range of a Kodachrome Commercial Film original. Contrast is approximately 0.50, to give optimum tone reproduction of prints on Eastman Color Print Film. Graininess has been made much lower than that of camera color films in order to minimize the granularity increase which invariably accompanies duplicating.

The characteristic curves for the reproduction of a scale of neutrals on Eastman Color Internegative Film are shown in Fig. 4. The three curves represent densities of the neutral scale to red, green and blue light, respectively, as measured on the Eastman Electronic Densitometer, Model 31, with Eastman Status K Filters. The higher blue and green minimum densities arise from the colored couplers which provide masking.

Raw-stock storage and latent-image keeping characteristics are quite similar to those described for Eastman Color Negative Film, Type 5248.

Exposure of Internegative From Kodachrome Commercial Film

Printing from Kodachrome Commercial originals onto Eastman Color Internegative Film, Type 7270, can be done on optical printers and on step- or continuous-type contact printers; however, more exposure is required for the internegative than is commonly used in printing onto black-and-white or Kodachrome Duplicating films. In specific tests, 25 to 50 times the exposure used for printing a Kodachrome Commercial original onto Kodachrome Duplicating Film, Type 5265, was required for printing that original onto Eastman Color Internegative Film. This increase in exposure can be attained by brighter light sources, more efficient optical systems, and slower printer speeds. Internegatives have been made on a Model J Bell & Howell Printer, with a 500-w lamp operating at 100 v. The printer was modified to run at the rate of 12 ft/min, and Light No. 16 was the average diaphragm used.

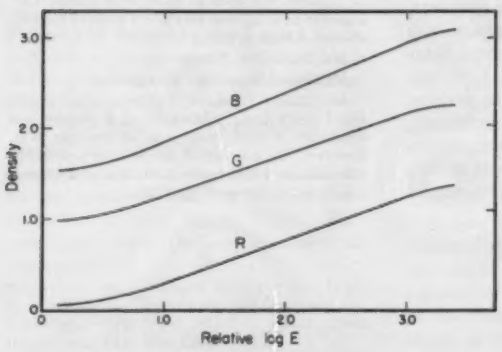


Fig. 4. Characteristic curve of Eastman Color Internegative Film, Type 7270: Exposure — intensity-scale sensitometer, 1/25 sec; Illumination — tungsten light plus Kodak Wratten Filter No. 2B plus 7-mm Pittsburgh No. 2043 heat-absorbing glass; Density — integral, Eastman Status K Filters.

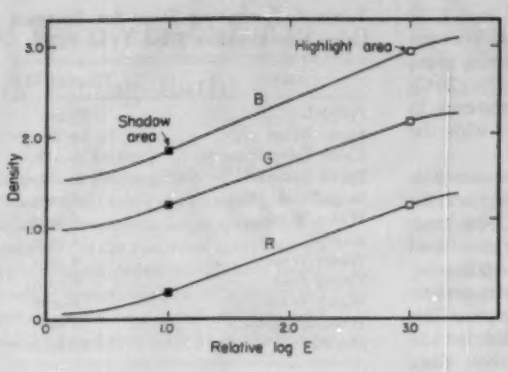


Fig. 5. Relation of picture density to characteristic curve of Eastman Color Internegative Film, Type 7270.

A Kodak Wratten Filter No. 2B is recommended for eliminating the shorter ultraviolet exposure which affects slightly the printing contrast of the Kodachrome Commercial original. A heat-absorbing filter, such as Pittsburgh No. 2043,* 3 mm or more thick, is desirable for use with the more intense light sources. Under such conditions, with a printer lamp operating at 90 to 110 v, only very small values of color-compensating filters are needed in printing normal Kodachrome Commercial originals onto the internegative film.

It may be desirable to use a step printer at this stage for optimum steadiness. This is because both the Kodachrome Commercial Film and the Eastman Color Internegative Film have 16mm perforations of 0.2994-in. pitch (short pitch) for convenience in contact release printing. In any contact printer, good contact at the gate is necessary to provide optimum picture sharpness. A well-placed jet of air at the gate, which forces the two films together, is an efficient way of obtaining the desired degree of contact.[4]

The Kodak Safelight Filter, Wratten Series 8, recommended for use with other Eastman Color products is adequate for use with Eastman Color Internegative Film. However, tests should be made under the actual conditions of use to determine exposure tolerance.

* Manufactured by Pittsburgh Plate Glass Co., Pittsburgh, Pa.

Sensitometry

The high residual color of the colored coupler mask and the presence of the colors in their complementary dyes in Color Internegative Film make it quite difficult to evaluate an internegative visually for correct density and color balance. Some other method than visual inspection is necessary for determining optimum internegative exposure. A densitometer equipped to read small areas with red, green and blue filters can be used to measure the red, green and blue densities of extreme highlight and shadow areas of picture material on the internegative film. These density values can be compared with the density range available in the internegative as given by the characteristic curve. The lowest printer exposure that will reproduce extreme shadow areas on the straight-line portion of the internegative film characteristic curve is the optimum exposure. Then there will be sufficient exposure latitude in the internegative film to permit the extreme highlights to be reproduced at higher densities still on the straight-line portion of the characteristic curve. Figure 5 illustrates this condition. The dark squares represent the shadow areas in a picture, and the light squares represent the highlight densities, each measured with red, green and blue light.

To determine the characteristic curve of Eastman Color Internegative Film, some means of providing a graded series of known exposure intensity to the internegative film is necessary. A high-intensity, intensity-scale sensitometer, or a printer or scene-tester provided with a calibrated density wedge provides such an exposure series. It is necessary to approximate the exposure time used in actual printing operations since the contrast of the internegative film changes when exposure times depart significantly from the 1/5- to 1/50-sec range encountered in motion-picture printers. The Eastman Intensity Scale Sensitometer, Model 15, and the Herrnfeld Sensitometer* have been used for this purpose,

* Manufactured by Herrnfeld Engineering Co., Culver City, Calif.

using exposure times of 1/25 and 1/10 sec, respectively. The Kodak Wratten Filter No. 2B and a heat-absorbing glass, such as 7-mm Pittsburgh No. 2043, should be used in the sensitometer to provide proper color balance with the high-intensity tungsten source.

The exposure scale thus obtained is developed in the process to be used for making internegatives, and the red, green and blue densities of the developed scale are plotted against the relative log exposure to provide the characteristic curve of the internegative film. The Status K Filters recommended for use with Eastman Color Negative Film, Type 5248,[1] are useful for densitometry of Eastman Color Internegative Film, Type 7270.

Besides providing a basis for determining correct internegative exposure conditions, the characteristic curve, when derived from reproducible exposures, provides a convenient monitor of film and process variations which aids in process and printer control.[5]

Printing Internegatives to Eastman Color Print Film, Type 7382

The procedures for printing Eastman Color Internegative Film, Type 7270, onto Eastman Color Print Film, Type 7382, are very similar to those for printing Eastman Color Negative Film, Type 5248, onto Eastman Color Print Film, Type 5382.[1] Modifications of 35mm printing equipment to obtain more light and more precisely controlled color-balancing and color-timing have been described.[6] These are adaptable to 16mm equipment. Because of small differences in color between Type 7270 Color Internegative and Type 5248 Color Negative, and because of differences in the portions of the sensitometric scales of the two materials used for recording the picture, the color of the balancing filter-pack (or the relative settings for red, green and blue light in an additive printer system) used for printing from internegatives may be different from that used for printing from Eastman Color Negative Film. Again, good contact is essential between internegative and print film to minimize losses in picture sharpness.

Cleanliness in the laboratory and careful handling of the film[7] are very desirable at this stage because dirt and scratches on the internegative will appear as objectionable white specks in the final print.

Processing of Eastman Color Internegative, Type 7270

The processing steps for Eastman Color Internegative Film, Type 7270, are shown in Table I. This is the process recommended for Eastman Color Print Films, Type 5382 and 7382,[1] with two exceptions. Time of development is reduced to 6 min, approximately half the recommended development time for Eastman Color Print Film. This change is required to produce the desired sensitometric characteristics and fine grain. This 6-min development time may vary from one type of processing machine to another, owing to mechanical differences which affect agitation and degree of development. However, when processing both color-print film and internegative in the same machine, the reduced development time should not be attained simply by speeding up the machine from the rate used in processing color-print, since other solution times may be reduced beyond tolerance limits.

Table I. Processing Steps for Eastman Color Internegative Film, Type 7270

Step	Time at 70 F
Prebath	10 sec
Spray Rinse	10 to 20 sec
Color Development	(±0.5 F) 6 min
Spray Rinse	10 to 20 sec
Stop Bath	4 min
Water Wash	4 min
Bleach	8 min
Water Wash	4 min
Fixing Bath	4 min
Water Wash	8 min
Wetting Agent	1 sec
Drying	15 to 20 min

The final stabilizing bath recommended for Eastman Color Print Film is not necessary for the internegative film and may be replaced by a rinse in a wetting agent only, to prevent water spots. When color internegatives are to be kept for future use and stabilization is desired, then the Stabilizing Bath (Kodak S-3) used in processing Eastman Color Negative Film, Type 5248, is recommended. The antihalation backing of the internegative film is similar to that used on Eastman Color Print Film and requires the same care in removal.

Processed internegatives require care in handling and in storage to prevent accumulation of dirt and scratches and to prevent deterioration of film support and images. Controlled relative humidity will help achieve both these purposes. Storage at high relative humidity will promote growth of molds, physical damage to film, and dye changes. Very low relative humidity causes film to develop excessive curl, brittleness and shrinkage, in addition to promoting static conditions which increase the amount of dirt and dust. A relative humidity between 50 and 60% at temperatures of 70–75 F are optimum for workrooms, and lower temperatures are preferable for film storage.

References

1. W. T. Hanson, Jr., and W. I. Kisner, "Improved color films for color motion-picture production," *Jour. SMPTE, 61:* 667–701, Dec. 1953.
2. W. T. Hanson, Jr., "Color negative and color positive film for motion-picture use," *Jour. SMPTE, 58:* 223–238, Mar. 1952.
3. T. H. Miller, "Masking: a technique for improving the quality of color reproductions," *Jour. SMPE, 52:* 133–155, Feb. 1949.
4. H. F. Ott and R. C. Lovick, "Improving contact motion-picture printers through the use of internally directed air," presented at the 79th SMPTE Convention on April 30, 1956, in New York City. To be published.
5. A. M. Koerner, "The problems of control of the color photographic processes," *Jour. SMPTE, 63:* 225–230, Dec. 1954.
6. J. G. Streiffert, "A fast-acting exposure control system for color motion-picture printing," *Jour. SMPTE, 59:* 410–416, Nov. 1952.
7. Report of the Committee on Laboratory Practice, *Jour. SMPE, 26:* 345–405, Apr. 1936.

Discussion

Forrest Jennings (Color Reproduction Co.): When will this stock be available?

Mr. Zwick: I understand that the motion-picture film department of Eastman Kodak Co. will have it quite shortly. You can contact a member of that group and get more precise information.

John B. Olsson (Houston-Fearless): Was the original Kodachrome of this material Type A or was it commercial?

Mr. Zwick: This was on Commercial Kodachrome.

Earl W. Heister (U.S. Army Signal Corps): There seems to be some confusion. There has been the impression that Kodachrome Commercial was a Type B negative-type color film. Can you clarify this statement, please?

Mr. Zwick: Yes, I think someone else may have confused you earlier, because the Kodachrome Commercial Film is a Type B Kodachrome-type film, a reversal film. There has been, as far as I know, no 16mm color negative-type film sold with a Kodachrome name.

Mr. Heister: Do you use this as just a general term — or do you apply it to a specific type of film?

Mr. Zwick: There are two types of motion-picture film called "amateur Kodachrome," a daylight and a Type A film, and then there is a third camera original 16mm reversal film called Kodachrome Commercial Film, Type 5268, which is aimed primarily at the professional field, and this internegative film has been made primarily to go with those Kodachrome Commercial originals.

Paul S. Peters (Motion Picture Advertising Service Co.): Have you tried to print from 35mm color negative onto 7270 to produce a positive for subsequent release printing on 5269?

Mr. Zwick: No, I haven't.

Mr. Peters: Would the dyes match?

Mr. Zwick: I believe the dyes would match but I don't know what kind of a picture you would get. I have never seen an example of it. However, the contrast of the positive product in this manner would be much too low to produce a satisfactory print on Type 5269.

A Practical Device for the Recovery of Silver and Prolongation of Life of Fixing Baths

By CHARLES E. DUISENBERG

Recovery of silver from fixing baths and consequent prolongation of the useful life of solution can be accomplished by simple electrolysis using currents of 150–175 ma. These methods are ineffective in an installation processing large quantities of film because silver deposited in the solution soon exceeds the recovery rate. Various physical-chemical expedients, combined with electrolysis, were tried, these being such as would allow the use of higher currents while preserving the integrity of the thiosulfate ion. These tests have led to the development of a small, flexible and efficient silver recovery unit which makes possible significant savings in chemicals and recovered silver.

Radiologists and photographers know that the main factor in exhaustion of the fixing bath is the accumulation of silver. The silver is not readily recoverable from the solution, so the common practice is to use the fixing bath until it becomes "slow" and then to discard it or sell it for a small fee to a solution service that will probably recover the silver by chemical substitution using zinc or iron. Chemical precipitation has also been used.[1] Both methods render the solution unfit for further use.

It has long been known that some silver could be recovered from fixing solutions by electrolysis, but it was not until the work of Garbutt and Ingman[2] that the factors involved in designing an efficient device were understood. Their work was followed by additional excellent work and development of a practical electrolytic silver recovery process by Hickman and Weyerts.[3] This process, or some minor modification of it, has been in use for the past twenty years in the larger motion-picture and photographic processing plants where it is economically feasible to use a Hickman cell which is initially expensive and involves fairly high maintenance and operating costs.

Interest in silver recovery for the smaller processing plants has been increasing in the last few years with the largest interest being in Great Britain in the Purhypo Process[4] which was developed by Doffin and marketed by D. Pennellier and Co., Ltd. Similar units have been developed by Willier,[5] Fisher[6] and Baker[7] in the United States and are enjoying some success. Kare Heiberg[8] in Norway has used a modification of this principle.

In all types of electroplating the amount and rate of silver recovery are a direct function of the amount of plating surface available and the current density. The Willier, Baker, Fisher, Purhypo and Kare Heiberg processes all use, by necessity, low current density[10] and therefore have a relatively slow silver recovery rate which can be accelerated only by adding more plating surface. If high current density is used in this type of unit, silver sulfide will be formed and the fixing solution ruined. These units have the advantage of being so constructed that they will fit in the fixing tank and allow continual operation while the tank is actually being used. However, in the usual busy x-ray laboratory the rate at which silver is dissolved into the fixing bath exceeds by far the ability of these units to recover the silver and "poisoning" of the solution continues. This can be compensated for to some extent by using multiple units and allowing the units to run overnight or when the fixing bath is not being used. Maintaining a low silver concentration in the fixing solution is of great value because by so doing it is possible to keep the fixing time relatively constant and to reduce the hazard of staining clothing with spots of fixing solution; furthermore, the relative quantity of silver lost into the washbath when the films are removed from the fixer is kept at a minimum.

It is apparent that any device for recovering silver and prolonging the life of the fixing bath should have great flexibility so as to be adaptable to varying concentrations of silver. It should possess the ability to reduce the silver concentration rapidly when necessary and still be able to run at low current densities when that is all that is essential to maintain the silver concentration at a low level. The device to do this should be portable and adaptable to the usual x-ray fixing tank. This would allow it to be used just as effectively in the radiological office as in the large hospital or clinic. With these considerations in view, the Palo Alto clinic began five years ago to develop such a device.

Single stainless-steel cathodes and graphite anodes were first used on opposite sides of the fixing tanks and the number of elements gradually increased to improve the efficiency. All of the experiments were confined to fixing solutions using sodium thiosulfate because experience has shown that the staining of clothing is less than in solutions using ammonium thiosulfate. Using these simple devices it was found that if current densities exceeding 150–200 ma/sq ft of plating surface were used in solutions of pH 5.6 or less a cloudy black precipitate was obtained on the plates, thus turning the entire solution into a gray-black suspension of silver sulfide. When the pH of the same solution was raised above 8 with sodium hydroxide the same thing occurred with current densities varying between 70 and 100 ma/sq ft.

The chemistry of sodium thiosulfate solutions is very complex; however, the following will give some understanding of what is involved in the sulfiding process. Most of the silver in the fixing bath is present as sodium-argentothiosulfate which dissociates as follows:

$$NaAgS_2O_3 = Na^+ + AgS_2O_3^-$$

Thus, we see that the majority of the silver is carried in a negatively charged ion and will be attracted to the anode. Actually, the silver is carried in many very complex ions of the same basic composition, but this will serve to illustrate the reaction. The reactions about the cathode are complex and not well understood. However, a simplified explanation may be achieved by postulating that sodium cations are liberated at the cathode and these being very reactive do not plate out but remain in solution and aid in the dissociation and decomposition of any complex ions in the vicinity as follows:

$$Na^+ + e \leftrightharpoons Na^0$$

$$2Na^+ + AgS_2O_3^- = Na_2S_2O_3 + Ag^+$$

$$\Downarrow$$

$$2Na^+ + S_2O_3^{--}$$

Metallic silver is then deposited at the cathode as follows:

$$Ag^+ + e = Ag^0$$

It can be seen that the deposition of silver is a secondary reaction at the cathode and that the initial migration of the silver-bearing ions is to the anode. Thus, any physical expedient producing flow of solution from the anode to the cathode and flow of the ions in the already treated solution away from the cathode is advantageous.

A simplified explanation of another reaction going on at the cathode affecting the thiosulfate is as follows:

$$S_2O_3^{--} + 2e = SO_3^{--} + S^{--}$$

Dissociated sulfur and silver are then

A contribution submitted on June 11, 1956, by Charles E. Duisenberg, M.D., Dept. of Radiology, Palo Alto Medical Clinic, 300 Homer Ave., Palo Alto, Calif.

available to form the noxious silver sulfide as follows:

$$2Ag^{+} + S^{--} = Ag_2S$$

We have found experimentally that this reaction occurs more readily in alkaline solutions. It is also true that the reaction at the cathode breaking down the thiosulfate ion is a reversible one, and that if there is a sulfite ion present in the solution this reaction is inhibited by the law of mass action; hence, the formation of a free sulfur ion can be inhibited. It also seems to be true that if the solution interfaced between the cathode and the main bulk of the solution is moved rapidly either by external agitation from air passing through the solution[2] or paddles,[3] or if the cathode is actually physically moved itself,[9] the breakdown of the thiosulfate ion will be less likely to occur. A simple postulate for understanding this is that the free thiosulfate ion is physically thrown a few molecules away from the cathode where it can be attracted by reactive sodium or silver ions.

In the Hickman cell this motion of the solution past the plating interface is accomplished by paddles rotating between the cathode and anode plates on a central shaft. We tried to produce this agitation by various paddle methods which might be inserted and removed in an ordinary x-ray fixing tank, but all of these proved to be cumbersome, extremely inefficient and spotty in the circulation that they produced. We then tested various forms and shapes of anodes which were moved through the solution. The first attempt at this was made by oscillating a single plate and we found that the current density could be increased somewhat before silver sulfide formation occurred.

We next used various forms of paddles moving through the solution with the paddle acting as the cathode; this was a little more successful but silver sulfide was formed wherever the solution produced a "burble or ripple" past a paddle. We then tried a rotating rod of large caliber as the cathode with peripheral anodes of graphite. This was much more successful and produced an excellent plate of silver but did not offer much plating surface.[9]

We tried many methods of increasing the plating surface and finally came to a series of disks which would rotate about a central shaft inserted vertically into the solution with the carbon anodes peripheral to these disks. This combination accomplishes all of the requisites of allowing satisfactory plating. The plates are flat so there is a minimum of centrifugal swirl produced in the tank itself, while the solution immediately adjacent to the plates, which has come under the action of the cathode, is swirled by centrifugal force out into the main mass of solution in the fixing tank. This produces a small area of relatively decreased pressure in between each plate. Fresh solution that has come into contact with the anode (including the negatively charged silver thiosulfate ions which tend to concentrate about the anode) is pulled into the space between the cathode plates where silver precipitation occurs. Initially in the plating operation the silver builds up evenly over the entire surface of the cathode disk. As plating continues the outer 0.75 cm builds up silver somewhat thicker than across the rest of the plate.

Confirming the results of earlier experiments, we soon found that the higher the current density the more rapid is the necessary rotation of the plates (or movement of the solution) to avoid sulfide formation. Fortunately, the outer portion of the plating disk moves more rapidly at a point where the current density is highest; points closer to the central rotating shaft have a slower speed of angular motion but, also, the distance from the anode is greater so that the current density is proportionately diminished and sulfide formation does not occur. If disks $5\frac{1}{2}$ in. in diameter are rotated at 175 rpm plating can safely be carried out between 0 and 10 amp, without appreciable sulfide formation, when precautions of maintaining acidity and sulfite concentration are taken. In the unit shown in Figs. 1 and 2 the central shaft and plating disks are made of type-316 stainless steel and the spacers in between the plates are made of carbon, as are the anodes. The top of the unit is made of nonconducting Plexiglass sheet and is designed to fit the usual fixing tank of 10-gal size or larger. All bearings are above the solution and never come in contact with it. Direct current is supplied to the cathode and anodes by a full wave bridge-type of selenium rectifier with an autotransformer providing variability of current.

It was found that an average of 800 mg of silver is deposited in the fixing bath for every 14 × 17 screen-type film. Nearly all of this silver is recoverable and the loss from carry-over of the silver solution of a high concentration into the wash water is minimized by frequent use of the processing unit to remove the silver and keep it at a low concentration. By using this method the useful life of the hypo may be prolonged from eight to ten times. The recovered silver can be readily harvested from the plates by removing the nut at the bottom of the shaft and sliding the plates off. The disks are then bent between the thumbs and forefingers in two or three directions and the recovered silver falls off without

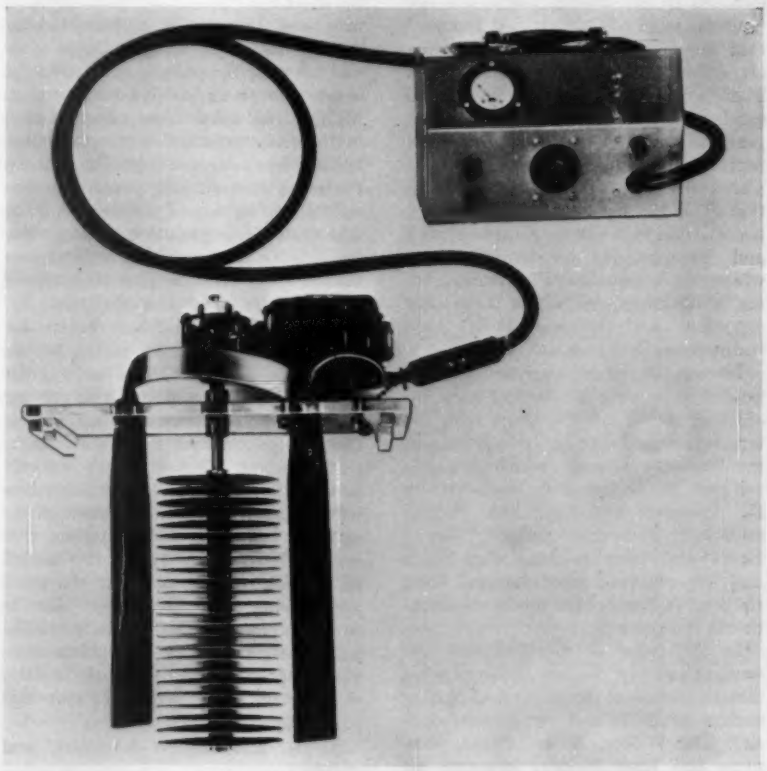


Fig. 1. The electrode unit (shown at lower left) fits on the top of the fixing-bath tank. The central cathode rotates and the two lateral carbon anodes are stationary. The rectifier in the upper right is of conventional design. Variability of current is provided with a Variac-type auto transformer.

Fig. 2. The electrode unit in place in the fixing-bath tank.

Fig. 3. Metallic silver as it is recovered from the cathode disks. It averages 94 to 96% pure silver.

difficulty (Fig. 3). A loaded cathode can be completely cleaned in twenty minutes.

After continued use, developer carried over into the fixing solution builds up in concentration, and when current is passed through the solution turns brown. A small amount of dark silver sulfide is formed even if conditions are scrupulously watched. Gelatin in solution also precipitates out on the cathode and is deposited in the solution as complicated silver conjugates which produce a sludge in the tank. At this point it is advisable to increase the current so that all of the silver will be recovered from the fixing bath and then discard the solution. The carry-over of developer is minimized by sufficient washing, and when we have used the two-fixing-tank system the second fixing tank has always run much longer than the first before becoming discolored. This is due to less carry-over of developer.

This device will work successfully with most fixing bath formulas. The following has been found to be satisfactory:

Water, about 125 F	4 gal
Sodium thiosulfate (micro-crystal)	12 lb
Sodium sulfite (desiccated)	8 oz
Potassium alum	8 oz
80% acetic acid	16 fl oz
Cold water to make	5 gal

Replenishing is done with sodium thiosulfate crystals and dissolved sulfite and alum in approximately the same proportions. Maintaining the sulfite concentration facilitates silver recovery on the cathode and minimizes sulfide formation. An excess of sodium thiosulfate should be avoided as concentrations above 60% will produce slow fixation just the same as low concentrations or saturation with silver.

For the past six months the Clinic has used a unit like the one shown in Figs. 1 and 2 in a separate tank. The solution is circulated through the tank which contains the processing unit and then through a small Fiberglas filter. This is a very satisfactory arrangement which allows the increase or decrease of the rate of silver recovery during the day as the film load demands.

Acknowledgments

Thanks are due to Sydney F. Thomas, M.D., for his sustained interest and helpful suggestions; Thomas Marinkovich for many days and nights of technical work; and Robert Bedford and Walter B. Snook, of Walter B. Snook Manufacturing Co., for engineering assistance and for allowing us the use of their machine tools and instruments.

References

1. J. I. Crabtree and J. F. Ross, "The Recovery of silver from exhausted fixing baths," *Am. Ann. Photog.:* 159, 1937.
2. F. E. Garbutt and L. N. Ingman, "Method and apparatus for recovering silver from fixing solutions," U. S. Pat. 1,866,701, July 12, 1932.
3. Kenneth C. D. Hickman, and W. Weyerts, "Method for the recovery of silver from the used photographic fixing solution by electrolysis," U. S. Pat. 1,954,315, Apr. 10, 1934.
4. H. G. Doffin, "Process and apparatus for the electrolysis of photographic fixing baths," Brit. Pat. 476,985, Dec. 20, 1937.
5. Henry O. Willier, "Recovery of precious metals from photographic baths," U. S. Pat. 2,615,839, Oct. 28, 1952.
6. Fisher Silver Recovery Unit, Oscar Fisher Co., 100 N. Division St., Peekskill, N.Y.
7. Baker Electrolytic Silver Recovery Unit, Baker & Co., 113 Astor St., Newark 5, N.J.
8. Kare Heiberg, "Electrolytic silver recovery from fixing baths," *Acta Radiologica, 34:* ϕ3, 215–224, 1950.
9. Allan Haines, Personal Communication, Units developed by himself and the late David Boyle, used in motion-picture industry. These are soon to be marketed by the H.M.B. Co., 9007 Ashcroft, Los Angeles 48.
10. A. A. Rasch, and J. I. Crabtree, "Electrolytic recovery of silver from fixing baths at low current density," *Photo. Sci. & Tech.*, Series II, 2 ϕ1: 15–33, Feb. 1955.

Carbon Arcs for Television Studio Lighting

By R. B. DULL
and J. G. KEMP

The performance of typical carbon arcs suitable for TV studio lighting, particularly for special effects on stage and for process projection in both black-and-white and color TV are described. Color modified carbons, the light from which can be mixed with that from other types of light sources, with little or no filtering, are emphasized.

CARBON ARCS available for black-and-white television studio lighting were described in detail in 1946 by Bowditch, Null and Zavesky,[1] when the television industry was in its infancy. These included 8mm flame and 16mm High Intensity Motion-Picture Studio positive carbons designed for burning in Mole-Richardson Type 40 Duarc and Type 170 spotlight lamps, respectively. In 1948 a 16mm Super High Intensity Studio positive carbon was developed for the Mole-Richardson Type 240 lamp, generally referred to as the "Brute," and for process projection in the motion-picture industry. These carbons are still available for TV studio lighting.

Although spectral characteristics of light sources are of secondary importance in black-and-white television, they are of primary importance in color television. Spectral requirements for color television and spectral characteristics of a number of available light sources have been described by both O'Brien[2] and Gurin.[3] This paper will further describe the characteristics of arc carbons which may be suitable for black-and-white and color TV applications.

Process Projection

At the present time the most frequent application of the carbon arc in TV studio lighting, both black-and-white and color, is as a light source for process or rear projection. It is particularly applicable to color television, where a minimum screen brightness of 300 ft-L is required on the camera side of the screen.

An 11mm High Intensity Projector positive carbon has been used by some studios as a light source for process projection in both black-and-white and color television. A 13.6mm High Intensity Projector carbon can be used to greater advantage with a 4 in. × 5 in. aperture as a means of obtaining a more favorable distribution of light upon the screen, as well as a higher level of illumination. This carbon has a current range of 125–150 amp. Figure 1 shows the spectral energy distribution of the light from the crater of this carbon at 150 amp. Still better light distribution can be obtained with a 16mm High Intensity Studio carbon operating in the current range 150–160 amp, although the total screen light may be somewhat less than that of the 13.6mm High Intensity Projector carbon, in the same current range, because of its lower current density and brightness. The 16mm Super High Intensity Studio carbon at 225 amp has the same current density as the 13.6mm High Intensity Projector carbon at 160 amp, and its brightness is midway between those of the latter carbon and the 16mm High Intensity Studio positive. It may, therefore, be more advantageous to use it rather than either of the other two carbons.

In process projection most of the useful light has its origin in the crater of the positive carbon. The color temperatures of the light from the crater of the carbons described above are in the 5900 K to 6600 K range. These carbons can be used without filters for process projection in black-and-white television, where light from sources having different color temperatures can be mixed without distortion of the picture. In the case of color television, where all light must be of the same color temperature to prevent color distortions, the carbons can also be used without filters provided the entire stage is illuminated by the same type of light source. When the stage is illuminated with incandescent tungsten, however, filters must be used with the above carbons to reduce their color temperatures to a point where light from the two types of sources can be mixed without noticeable visual effects. The use of filters, however, appreciably reduces the available light.

Since the major problem in process projection for color television is one of obtaining an adequate light level, the most useful light source would be one with all the power and intensity of the carbon arc, but with a spectral quality similar to that of incandescent tungsten. A similar need in the motion-picture studios has led to the development of such a color-modified carbon, or yellow-flame carbon as it more commonly is called, for both lighting on the motion-picture set and for process projection. This carbon is a 16mm Super High Intensity Yellow-Flame Studio carbon, designed to burn at 225 amp. It has been described in detail in an earlier paper.[4]

In addition to the standard 16mm Super High Intensity Yellow-Flame Studio positive, two experimental yellow-flame carbons are available for evaluation as a light source for TV studios. One is a 16mm High Intensity Yellow-Flame Studio carbon for use in the 150–160 amp range, while the other is a 13.6mm High Intensity carbon designed to burn at approximately 150 amp. The former is being developed primarily for the motion-picture industry, and is subject to changes, if necessary for that application. The latter is being developed primarily for TV studio application.

Figure 2 shows the spectral energy distribution of the average crater light from the experimental 13.6mm High Intensity Yellow-Flame positive carbon at 150 amp. The curve has peaks at 600–610 and 530–540 mμ and valleys in the 570–580 and 480–500 mμ regions. Figure 3 is the spectral energy distribution of the average crater light from the experimental 16mm High Intensity Yellow-Flame Studio positive carbon at 160 amp. There is very little difference between Figs. 2 and 3.

Figure 4 is the spectral energy distribution of the average crater light from the 16mm Super High Intensity Yellow-Flame Studio positive carbon at 225 amp. The differences in energy between the peaks and valleys are not as great as those in Figs. 2 and 3, for the experi-

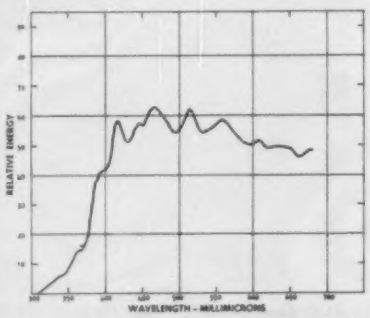


Fig. 1. Spectral-energy distribution of crater light for 13.6mm High Intensity Projector positive, 150 amp.

Presented on April 30, 1956, at the Society's Convention at New York by R. B. Dull (who read the paper) and J. G. Kemp, National Carbon Co., a Division of Union Carbide and Carbon Corp., Fostoria, Ohio.
(This paper was received on April 30, 1956.)

mental 13.6mm High Intensity Yellow-Flame and experimental 16mm High Intensity Yellow-Flame Studio carbons, respectively.

Table I gives additional characteristics of the standard and experimental carbons when used in a condenser-type 35mm motion-picture projection lamp with $f/2.0$ optics, and with a 0.600 in. × 0.825 in. standard 35mm motion-picture sound aperture and an $f/2.0$ projection lens. A 4 in. × 5 in. aperture is commonly used for process projection in TV studios. Apertures and optical systems for motion-picture projection differ so widely from those for process projection in TV studios that light on the process screen in the latter case cannot readily be calculated from the data in Table I. The data, however, do give an indication of what can be expected of the various carbons.

The third column of Table I gives the total screen light when the lamp is adjusted for maximum screen light. These figures indicate that the 13.6mm High Intensity Projector carbon at 150 amp produces more light than any of the other carbons listed. The magnification of the optical system is such that when 16mm carbons are used there is considerable spill over of light around the motion-picture aperture, thus a sizable portion of the light from these carbons has been wasted.

As previously stated, filters are required with non-color-modified carbons for process projection in color television to reduce the color temperature of the light to that of the light from incandescent tungsten, when the latter is used as a light source for general stage lighting. Filters used for this purpose reduce the light level by approximately 40%. The motion-picture industry has found that the filtering of light from the 16mm Super High Intensity Yellow-Flame Studio carbon is not necessary for process projection, when projection is done with a relay-condenser type optical system. Since this type of optical system is also used for process projection in TV studios, the assumption has been made that filtering will not be required with the yellow-flame carbons in this application. Column 4 of Table I shows the usable light produced by each of the carbons, assuming no filter is needed with the yellow-flame carbon, and 40% filter loss with non-color-modified carbons.

Table I. Screen Illumination With Condenser-Type 35mm Motion-Picture Projection Lamp With f/2.0 Optical System — 0.600 × 0.825" Aperture.

Carbon	Arc amperage	Max. screen lumens	Usable light in lumens	Approx. relative screen light	Side-to-center distr.	Relative Radient Energy Flux at center of Aperture‡
13.6mm H. I. Projector .	150	19,500	11,700*	100	60%	100
Exp. 13.6mm H. I. Y.-F.	150	18,000	18,000†	155	70	55
16mm H. I. Studio . . .	160	15,900	9,500*	80	55	80
Exp. 16mm H. I. Y.-F. Studio	160	15,700	15,700†	135	65	50
16mm Super H. I. Studio	225	17,600	10,600*	90	70	85
16mm Super H. I. Y.-F. Studio	225	18,900	18,900†	160	70	75

* Assuming 40% filter loss.
† Assuming filtering is not necessary.
‡ Assuming no filtering loss.

Column 5 gives the relative usable screen light with the 13.6mm High Intensity Projector positive carbon as a base. In general, the yellow-flame carbon produces 35–65% more usable light than the reference carbon, under conditions described above. The experimental 13.6-mm High Intensity, the experimental 16mm High Intensity Studio, and the 16mm Super High Intensity Studio Yellow-Flame carbons produce 55%, 65% and 75% more usable light, respectively, than their non-color-modified counterparts.

Column 6 shows that the experimental 13.6mm High Intensity Yellow-Flame and 16mm High Intensity Yellow-Flame Studio carbons produce higher side-to-center light distribution than do their non-color-modified counterparts. This is probably due to a change in shape of the luminous gas ball at the crater of the positive carbon as a result of shallower craters in the yellow-flame carbons. Since there is little or no difference in the crater depths of the two Super Studio carbons, there is no difference in side-to-center light distribution.

Since television techniques call for the continuous projection of a slide for as long as 30 min or more, heat at the aperture is an extremely important factor. The last column of Table I gives the relative radiant energy flux at the center of the aperture, assuming no filtering, with that produced by the 13.6mm High Intensity Projector carbon as a base. The radiant energy flux is considerably less with yellow-flame carbons than with their non-color-modified counterparts. In general it is 10–45% less, with the greatest difference being between the two 13.6mm carbons.

The color temperatures of the light from the craters of the various carbons are listed in Table II. As previously stated, the color temperatures for non-color-modified carbons are in the 5900–6600 K range. That of the two experimental yellow-flame carbons is 3400 K, whereas the color temperature of the 16mm Super High Intensity Yellow-Flame Studio carbon is 4100 K. The latter color temperature may appear to

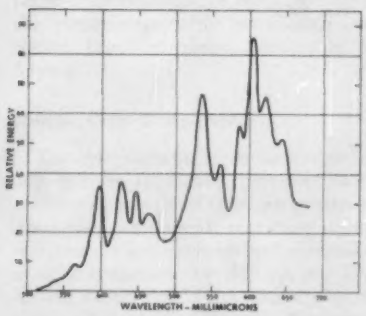


Fig. 2. Spectral-energy distribution of crater light for experimental 13.6mm High Intensity Yellow-Flame Studio positive, 150 amp.

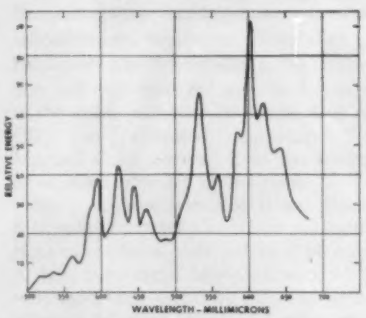


Fig. 3. Spectral-energy distribution of crater light for experimental 16mm High Intensity Yellow-Flame Studio positive, 160 amp.

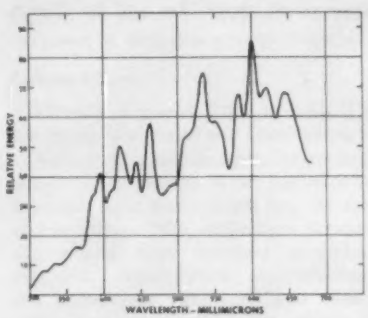


Fig. 4. Spectral-energy distribution of crater light for 16mm Super High Intensity Yellow-Flame Studio positive, 225 amp.

Fig. 5. A scene from "The Ten Commandments," Cecil B. DeMille's spectacle in VistaVision; A Paramount picture, Loyal Griggs A.S.C., Director of Photography.

Fig. 6. A scene from "Diane," an M-G-M picture; Robert Planck A.S.C., Director of Photography.

be too high without filtering, but as indicated above, the motion-picture industry is using it without filtering for process projection when photographing with 3200–3400 K color film.[4]

All color temperatures in Table II were determined from CIE trichromatic coefficients obtained from spectral energy distribution curves of the crater radiation.

Special Lighting Effects on Stage

In addition to process projection the carbon arc is a useful light source for creating special lighting effects upon the TV studio stage. It is extremely useful for simulating sunlight where the light level must be considerably higher than that for general stage illumination. Figure 5 illustrates how the motion-picture industry has used the carbon arc to create the effect of open shade and give the illusion of a semi-open structure. Without this special lighting effect the scene would appear flat, and the illusion of a semi-open structure would be greatly reduced, if not lost altogether.

The carbon arc is also capable of creating sharp shadows. At the present time no other light source can equal the carbon arc in this respect. In Fig. 6 the shadow pattern of the window lattice is well defined on the wall, not only creating the effect of sunlight streaming through the window, but also giving depth to the scene. The number of special lighting effects which can be created by using the carbon arc in this manner depends upon the ingenuity of the studio lighting engineer.

Table II. Color Temperature of Crater Light.

Carbon	Amp	Color temp.
13.6mm H. I. Projector. .	150	6100 K
Exp. 13.6mm H. I. Y.-F. .	150	3400
16mm H. I. Studio . . .	160	6600
16mm H. I. Y.-F. Studio .	160	3400
16mm Super H. I. Studio.	225	5900
16mm Super H. I. Y.-F. Studio	225	4100

Acknowledgments

The authors are indebted to H. M. Gurin and R. S. Lyons, National Broadcasting Co., for information regarding the lighting requirements for TV studios, and for the interest they have shown in the possible application of color-modified carbons to color television.

References

1. F. T. Bowditch, M. R. Null and R. J. Zavesky, "Carbon arcs for motion picture and television studio lighting," *Jour. SMPE, 46:* 441–453, June 1946.
2. R. S. O'Brien, "CBS color-television staging and lighting practices," *Jour. SMPTE, 63:* 41–50, Aug. 1954.
3. H. M. Gurin, "Color television light sources," *Jour. SMPTE, 63:* 51–54, Aug. 1954.
4. F. P. Holloway, C. A. Plaskett, R. B. Dull and C. W. Handley, "A 225 ampere motion-picture studio carbon for use with 3200–3400 K color film," *Jour. SMPTE, 64:* 657–659, Dec. 1955.

The Art of Color TV

By SALVATORE J. BONSIGNORE

Procedures outlined in this paper will attempt to compare black-and-white and color TV. Some procedures were developed and tested on a theoretical basis; others evolved after practical experience in color TV production. These techniques and procedures are offered with the intent of making commonplace the means for presenting creative color pictures which satisfy existing technical standards.

Color television requires light intensities five times the value for black-and-white, necessitating additional initial expenditures for lighting equipment, grid structures and control equipment. The highlight levels make it difficult for the lighting director to read the light on the set. It is far more difficult to light by eye a color set than a black-and-white set. Color necessitates the use of a photometer.

The physical bulk of the camera acts as a limitation on the height of the keylights. The lenses on a black-and-white camera are approximately eight inches from the top of the camera. The lenses on a color camera are approximately twenty-two inches from the top of the camera. This forces keylights higher and creates a problem in face modeling.

At CBS, it was found that the 1500-w scoops and the 1-kw, 2-kw and 5-kw spotlights blend together very well to provide the light level and the modeling that we desire. At the present time, it is necessary to employ the 3-kw tungsten spotlights rather than the carbon arc. The color temperature of the carbon arc is too blue to serve satisfactorily as a keylight or an accent light. Our light control instrument is a Century Izenour electronic board capable of handling 750,000 watts at a time.

Flat gray surfaces are extremely difficult to render as gray surfaces. Minor defects inherent in the electronics system show up as spurious coloring on the field. The biggest single limitation and that which vitally affects every phase of color broadcasting is the narrow range from highlight to black. With all the elements perfectly attenuated, the widest practical range obtainable is 1 f-stop.

Kelvin (Color Temperature)

The color cameras in use today can be adjusted to reproduce properly color pictures at any given color temperature. The only limitations regarding color temperature are economy and variations of color temperature within the set. The Kelvin values should not exceed plus or minus 100°. CBS Television has combined 2950 K scoops and 3200 K spotlights, giving an average of approximately 3000 K. It was ascertained that if the scoops had been changed to 3200 K, the initial cost and shorter life of the lamps would increase the overall cost approximately 60%. The ideal situation would be to use lamps in the spotlights with a Kelvin rating of 2900° or 3000°. The lower filament temperatures and resultant longer life of the lamp would afford greater economy and provide for longer period of stability.

Care must be exercised when dimming lights that are used for color television. It is safe to calculate on a loss of 10 K for every volt. This change in color temperature can be tolerated when it is rendered on scenery and on backgrounds. At CBS dimming is used to balance sets and to create artistic effects, but is never allowed where it would affect skin tones. Skin tone is regarded as the most important standard in the color picture. As long as skin tones appear natural to the public, the color picture will be successful. Variations in the background, such as a lighter blue or a darker blue, are far more acceptable to the viewing public than skin tone that does not seem quite natural.

Design

Design function is treated here in a very broad sense. Since costuming and set decoration are closely allied to design, and in many cases determined by the design, the following comments apply to all. The 1 f-stop limitation affects the designer as much as the lighting director. He must operate within a narrow limit of reflection and brightness. His ability to keep objects in the set within this limitation will determine the success or failure of the color picture. Charles Barkley of CBS has calibrated completely the Munsell Color System. This has served as an invaluable aid to designers.

Early in color television it was found that color contrast alone was not sufficient to render a good technical picture. A 40% reflectance blue next to a 40% reflectance red certainly afforded great contrast in color. However, when this same picture was viewed on a black-and-white monitor, the two surfaces blended together with no separation at all. This required the set designer to consider the luminance and reflectance of surfaces as well as actual color. It was discovered that scenery designed with depth and dimension would create shadow areas and roundness which helped immeasurably to produce good color and black-and-white pictures. It was found to be far more satisfactory to put molding and trim on the scenery rather than just painting it on, as was common in black-and-white.

In many cases where definite strong color is desired, it is far more effective to paint color in the object rather than depend upon colored light.

In respect to paints and fabrics, it was found that matte paints, velour and felt fabrics, because of their light diffusing quality, rendered color far more satisfactorily than specular fabrics, (i.e. silks and satins) and hard paints, (i.e. glossy enamel).

A 60% reflectance gray resolves itself on color TV as white. Since skin tones average from 35% to 45% reflectance, we have found that the backgrounds behind actors should be between 20% and 40%.

It may not be scientifically true, but it has been the experience of the author that any single hue can be accurately reproduced. When the hue is mixed with white to create a tint, the resolution on the color picture is generally lighter than that which appears to the naked eye. The converse is true, that any hue mixed with black to produce a certain shade generally resolves itself darker than appears to the naked eye.

Make-Up

In addition to the usual functions of make-up, such as wigs, hair, etc., there is another service that make-up renders to color. Because of the 1 f-stop limitation, it is frequently necessary to darken the skin tones of very fair people and lighten the skin tones of people who are sunburned or dark-complexioned. A wide variation of skin tone can be disastrous.

Gelatin Filters

The use of gelatin filters in color TV has many advantages and disadvantages.

Among the disadvantages, the greatest is the loss of energy. When we have to maintain light levels of 500 ft-c, the loss of from 30% to 90% of the light through the gelatin filter becomes a serious economic consideration. In addition, the tremendous light level and consequent heat generated has a tendency to burn gelatin filters quickly, altering the color and requiring many man-hours of preparation and replacement.

There is also a danger that the light

Presented on May 2, 1956, at the Society's Convention at New York by Salvatore J. Bonsignore, CBS Television, 485 Madison Ave., New York 22. (This paper was received on May 2, 1956.)

from the lamp with the gelatin filter may contaminate the light hitting a face. This has the adverse effect of making the face appear unnatural.

The chief advantage of the use of gelatin filters is in creating a mood. A scene representing lighting by a fireplace or old-fashioned gas lamps can be greatly augmented by the use of ambers, yellows, etc. The pinks and reds can also be employed to indicate warmth, happiness, etc. In the case of a cold exterior, blues can be employed advantageously. These are legitimate uses for gelatin filters, limited only by the ingenuity and artistic taste of the lighting director.

Actual experience and experimentation have convinced us that anything that can be done in black-and-white TV can be done in color TV; all that is required is a proper understanding of the limitations and the techniques that can be employed to compensate for the limitations. Technical advances in this field will put more tools in our hands to create more effective and beautiful pictures.

16mm Registration and Steadiness Test Film

A NEW 16mm test film that measures registration, aperture size, resolution, shutter timing, centering of the image, steadiness of its own test image with respect to the perforation, and also provides a "thousandths scale" for measuring film movement in double-exposure testing of printer steadiness has been added to the Society's catalog of films. Providing in a single test film of high accuracy several quantitative visual tests that have always been difficult to perform, this reel will be used for quality control by manufacturers of 16mm projectors, in film laboratories to adjust 16mm printers, and for precise alignment of 16mm black-and-white and color television film chains.

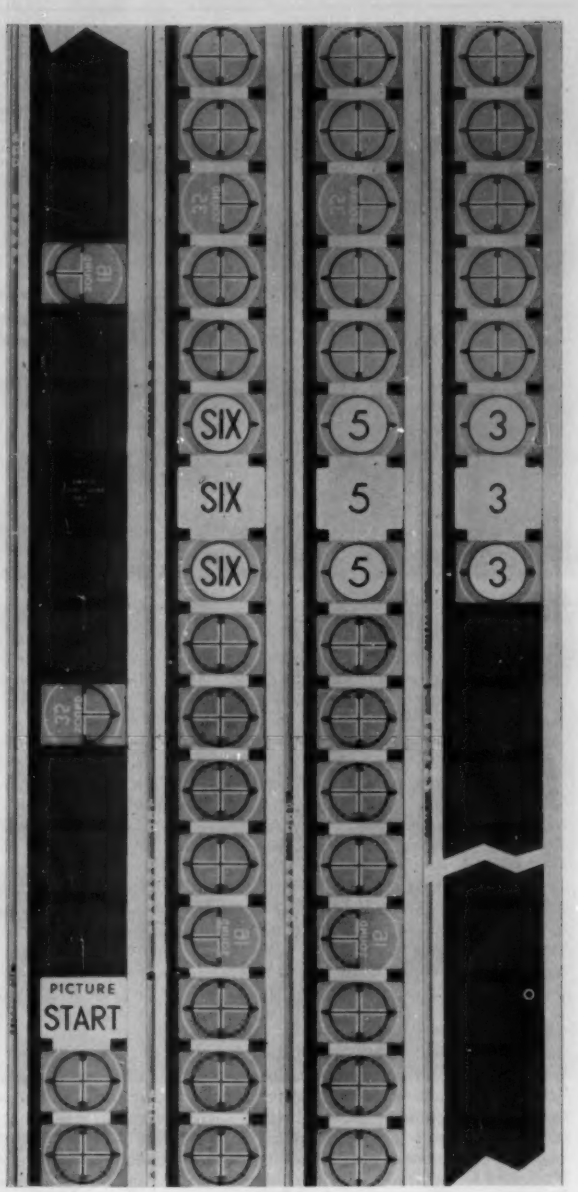
Development work on the film was done over a period of two and a half years by George W. Colburn of Geo. W. Colburn Laboratories, Chicago. The film, Code-Reg-16, comes in lengths of 100 ft and is priced at $27.50, available from the Society of Motion Picture and Television Engineers, 55 West 42d Street, New York 36, N.Y.

Threading Leaders for TV Films

THE FIRST negative of this leader, made in 1951, had, through a mistake, a rather dense bar running horizontally through the center of the frames which follow No. 3. Although many thousands of prints have been produced since that black bar was eliminated, there are still in use some master positives or dupe negatives of the leader, showing this bar. They should be disposed of and replaced with either 45 to 50 frames of black film (clear in the negative) or with a new leader. The latter is preferable because those trailing frames were intended to have a density of about 1.6 as a concession to improved performance with iconoscope film chains. Black film of high density is less satisfactory for television reproduction.

Since its introduction by the Society early in 1951, the film leader shown here has become a trusted friend of television projectionists in all stations in the United States. It is familiar to all producers of commercial films and to all laboratories. It serves as a threading guide and because the sequence of numbers, as well as the spacing between them, is operationally similar to the familiar "academy" leader previously used on all theatre prints, its essential details comply with American Standard Z22.55-1947, last published in the March 1948 *Journal*.

Fine grain master positives of this leader have long been available from SMPTE headquarters. They come three to a roll in continuous length, $5.00 in 35 mm, $2.00 in 16mm. Dupe negatives of this leader are frequently spliced to the picture printing negative for commercial films so that resulting projection copies have their own leaders attached, or prints from dupe negatives of this leader are spliced to the head ends of assembled rolls of television film to be integrated into live television programs. It is important that the switching cue — the little round circle that appears 40 frames after the No. 3 — not be lost through repeated splicings. If it must be chopped off, some other recognizable cue should be substituted so that the video control engineer or technical director will not find himself without the usual switching cue.



news and reports

Fall Convention Program

The nation's film capital is the appropriate setting for what promises to be one of the most important conventions of recent years. The centrally located Ambassador Hotel offers spacious accommodations in delightful surroundings. In 1953 the Convention at Los Angeles broke all previous attendance records, and the 80th Convention is expected to shatter that record.

The serious and important reason for the convention is, of course, the presentation of technical papers, the exchange of ideas in discussions, and the informative exhibits of new products and developments. But, as a well balanced meal offers salad and dessert in addition to the meat course, the Convention also offers exciting social events and carefully planned excursions for members, their wives and everyone attending the Convention.

The Get-Together Luncheon will be held October 8 at 12:30 in the Ambassador's beautifully decorated Embassy Room. On Tuesday, October 9, the ladies' program will have a special feature — an all-day trip through Disneyland. The trip will include transportation from the Hotel to Disneyland and return, tickets to ten rides, luncheon at the Red Wagon Restaurant, and a special showing at the Golden Horseshoe Theatre.

The peak of the week's social activities will be reached Wednesday evening. The festivities will begin with an aquacade held in, and a cocktail party around, the Ambassador's swimming pool. After the cocktail party the banquet will be held in the famous Cocoanut Grove, departing from tradition to the extent of offering a genuine Hawaiian Luau (feast). Music will be by a Hawaiian quartet in addition to the regular Cocoanut Grove orchestra and entertainment. Dress for the occasion will be semi-formal with the ladies looking their prettiest and most elegant and the men acting as a distinguished but unobtrusive background to the glitter and glamor.

The Awards Session will be held Tuesday evening, October 9 at the Ambassador Hotel. S. Eric Howse, Technicolor Motion Picture Corp., has been appointed Chairman. Dr. William H. Pickering will speak on "Project Vanguard — The Earth Satellite." At this session the Convention will honor those who have made outstanding contributions to the advancement of motion-picture or television engineering.

Papers Program

To return to more formal matters, during Convention Week seven main topics will be covered in 15 sessions (July *Journal*, p. 387). Considerable interest has been expressed in the Transistor Session. Among the important papers that will be presented are "Transistors and Vacuum Tubes," by Dr. Robert D. Middlebrook, California Institute of Technology; and "Transistors — General Applications," by Richard B. Hurley, Convair. Other papers, tentatively scheduled, cover specific application of transistors to motion-picture and TV engineering and a description of a 50-w amplifier.

Among the papers scheduled on other topics are: "The Reversed Anamorphic Projection Lens (Panavision)"; "The IPC Curved Film Gate"; "An Adjustable Curved Screen Frame"; "Magnetic Film Bulk Erasing Systems," and "The M-G-M 65-mm Process."

The reversed anamorphic projection lens for CinemaScope projection squeezes the picture vertically rather than expanding the picture horizontally. This lens is of special interest to theaters using local focal length lens since it results in higher screen brightness and a sharper picture.

The International Projector Corp. curved film gate will be demonstrated under high light levels to show the improvement in picture sharpness.

An adjustable curved screen frame will be described and demonstrated. This frame permits adjusting the curvature of a motion-picture screen from a very deep curve to flat to accommodate the various film systems.

Several major studios have designed and built excellent bulk erasing equipment. The paper on this subject describes the best of these in detail giving construction details and performance.

The new M-G-M 65mm process will be described and demonstrated during an evening session at the M-G-M studios. At this same session there will be two papers from Westrex on 6-channel stereophonic sound equipment with demonstration. At this session there will also be a paper on the 65–35mm Simplex projector, as well as a demonstration of the reversed anamorphic projection lens.

For the other sessions there is definite assurance of a paper from du Pont on the dielectric splicer; a paper on the Cinemiracle process; a paper on "The Analysis of Background Process Screens," and a paper by Ralph Evans of Eastman Kodak on "Contrasts and Sharpness in Motion Pictures."

Ampex is planning a full technical description with demonstrations of their video tape recording process — as a follow-up of the Spring Convention presentation (May *Journal*, pp. 302–304).

Under Program Chairman Petro Vlahos (who is also the Papers Committee Vice-Chairman in the Convention location area), Topic Chairmen function locally to develop one or more sessions. In addition, the other Vice-Chairmen under Papers Committee Chairman *Ralph E. Lovell* help build each program. They are: *J. E. Aiken, G. G. Graham, C. E. Heppberger, B. D. Plakun* and *J. H. Waddell.*

Operating in special areas are two very important members of the Committee: *Glenn E. Matthews* at Rochester, N.Y.; and *Walter S. Tesch* at Camden, N.J.

Although the deadline is past for authors to submit forms for papers to be described in the postal notice about the Convention and although manuscripts must be in the Editor's hands by August 31, prospects for papers or demonstrations of vital interest may still be taken into account if any of the following is advised by wire:

Program Chairman: *PETRO VLAHOS*, c/o Motion Picture Research Council, 6660 Santa Monica Blvd., Los Angeles 38, Calif.

TOPIC CHAIRMEN

Television — General: *Frank J. Gaskins*
Laboratory Practice: *William E. Gephart, Jr.*
Transistors and Transistor Applications: *Kurt Singer*
Projection & Exhibition: *Merle H. Chamberlin*
Motion-Picture Practice: *Frank E. Milton*
Instrumentation & High-Speed Photography: *Roy L. Wolford*

Equipment Exhibit

John B. Olsson, Houston Fearless, 11801 W. Olympic Blvd., Los Angeles 64, is SMPTE Exhibit Committee Chairman. Full information about the booths, facilities and arrangements was mailed early in July to all exhibitors at past conventions and all known prospects. All others having an interest in knowing more details about the Exhibit should write to John Olsson.

Local Arrangements

Under Convention Vice-President Byron Roudabush, a considerable host of workers do the local arranging and worrying, and put on the show:

Local Arrangements Chairman — *Edwin W. Templin*
Exhibits: *John B. Olsson*, assisted by *Craig Curtis*
Hotel Arrangements: *Robert G. Hufford*
Registration: *Charles W. Handley*
Auditors: *Arthur Johnson* and *H. J. Herles*
Ladies' Committee Co-hostesses: *Mrs. John G. Frayne* and *Mrs. Norwood L. Simmons*
Hospitality: *Cameron G. Pierce*
Transportation: *Grant Graham*
Entertainment: *Sidney P. Solow*
Awards Session: *S. Eric Howse*
Banquet: *Alan Gundelfinger*
Luncheon: *G. Carleton Hunt*

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James L. Pettus and *John Stork*
Publicity: *Martin Waldman, Sue Grotta, Mrs. Alan Gundelfinger*
Membership: *Harry Lehman*
Administrative Assistant: *Herbert E. Farmer*

Engineering Committee Meetings

Chairmen of the Society's 14 Engineering Committees are being canvassed about their plans for Fall Convention Week. It is expected that most of the committees will have their usual full agenda and that some ten or more committee and subcommittee meetings will be held during the week.

The Ambassador Hotel

The postal announcement for the 80th Convention will be mailed to the membership by August 15. It will contain hotel reservation cards for the Ambassador, the rates for which are: Single room with bath, $9.00, $11.00, $13.00, $15.00 and $17.00 per day; double room with bath, $12.00, $14.00, $16.00, $18.00 and $20.00 per day; parlor, bedroom and bath occupied by one person $25.00, $27.00, $31.00 and $33.00 per day; parlor, bedroom and bath occupied by two persons, $28.00, $30.00, $34.00 and $36.00 per day. Garden Studios are available with full hotel service and easily accessible to the main building. Rates are: room with bath occupied by one person, $15.00, $17.00, $19.00 and $21.00 per day; occupied by two persons, $18.00, $20.00, $22.00 and $24.00 per day. Room with private sun deck or terrace, occupied by one person, $19 and $23.00 per day; occupied by two persons, $22.00 and $26.00 per day; large living room, bedroom and bath, occupied by one person $35.00 per day; with large private sun deck, $45.00; large living room, bedroom and bath occupied by two persons $38.00 per day, with large private sun deck, $48.00.

The announcement will also contain a pre-registration card to permit advance registration, with discount, in accordance with the practice for recent conventions.—*R.H.*

Elements of Color in Professional Motion Pictures

A book of 80 pp. or more, including 28 pp. in process color, is in preparation by the Society. It is the product of a Subcommittee of the Color Committee. Wilton R. Holm, Chairman of the Subcommittee, has organized the text in eleven chapters:

Color Fundamentals · Characteristics of Colors · Color Films and Processes
Planning a Motion Picture in Color · Photographing a Motion Picture in Color
Color Photography Outdoors · Color Photography in the Studio · Special Effects
Color Processing and Printing · Motion Pictures and Television · Visual Effects

With a budget approved at the August 3 meeting of the Board of Governors it is planned to expedite production of *Elements of Color in Professional Motion Pictures* for release early in December.—*Ed.*

Cumulative Index for 1951-1955 Journals

At the August 3 meeting of the Board of Governors it was decided to publish a five-year index to succeed the previous cumulative indexes, the last of which was for 1946–1950.

The new index will supplant the volume indexes, of which there were two each in the years 1951–1954, then one in December 1955 for the first year in which the Journal was in a single volume.

Suggestions for arrangement of the large index and advice about errors or omissions in past indexes are requested. It is planned to release the five-year index with the November *Journal*. An index for the 1956 volume will accompany the December issue.—*Ed.*

ERRATA — A Directory for Members, April 1956, Part II

Errors brought to the Editor's attention during two months after publication are:

Officers and Managers of Sections

PACIFIC COAST: Managers are — Lester H. Bowman, Merle H. Chamberlin, Karl Freund, Robert G. Hufford, G. Carleton Hunt, Cameron G. Pierce

Sustaining Members

For: **Titra Film Laboratories, Inc.,** 1600 Broadway,
Read:———, 1501 Broadway, New York 36, N.Y.

Fellows of the Society

Inexplicably omitted from this list were:
Gordon, George H.
Hill, Armin J.
Iwerks, Ub
Miller, Everett
Schmidt, Edward
Teare, Ralph A.
Wetzel, W. W.

Consolidated List of Members

For: **Davis, Jack R.,** Sound Mixer, Signal Corps Photographic Center, . . .
Read:———, Production Mgr., Transfilm, Inc., . . .
For: **Hastings, L. Lyon,**
Read: **Lyon, L. Hastings,**
For: **Hoad, Malcolm C.,** etc.
Read:———, Broadway Theatre, Woolloongabba, Queensland, Australia. (A)
For: **Martin, Leslie,**
Read: **Martin, Les,**
For: **Pike, Kelvin S.,** Radio Technician, Shell Film Unit.
Read:———, Asst. Cameraman, Elstree Studios, Associated British Picture Corp.
For: **Townsend, James Harvey, Jr.,** Vice-Pres. and Chief Eng., Unifilms, Inc.
Read:———, Exec. Producer and Sound Supvr., Dynamic Films, Inc.

engineering activities

This report presents a résumé of the major aspects of the engineering committee meetings held during the Society's 79th Convention in New York City, April 29–May 4, 1956.

Film Dimensions

Three proposed standards had been under consideration and ballot by this committee prior to the meeting:

Dimensions for 32mm on 35mm Negative Motion-Picture Film (Revision of PH22.73-1951)
Dimensions for 16mm Short-Pitch Film With Perforations Along Two Edges
Dimensions for 16mm Short-Pitch Film With Perforations Along One Edge

Much time was spent reviewing questions raised in the course of the balloting. In the end, these questions were resolved and the three proposals were approved for further processing as American Standards.

Action was taken to bring Z22.31-1946 up to date. This standard specifies that all 8mm, 16mm, 32mm film shall be safety film and comply with Z38.3.1-1943, American Standard Definition of Safety Photographic Film. The proposed revision adds 35mm film to the previous list and substitutes PH1.25-1956, Definition of Safety Photographic Film, for Z38.3.1-1943.

The last few years have witnessed the introduction of new motion-picture film differing from existing film in perforation and pitch. In developing standards for these films a vexing problem has arisen with respect to the titles. This problem was compounded by the inadequacy of many of the titles of existing film standards where film titled as positive or negative was not restricted to either one or the other use. At the previous meeting, Mr. Brandsma had been assigned the task of preparing a consistent set of titles for all film dimension standards. He presented such a set of titles at this meeting and this was approved, with minor modifications, for ballot of the entire committee.

Film Projection Practice

The three proposed aperture standards for anamorphic prints were reviewed. It was noted that production of Superscope prints for the square aperture have been discontinued. The committee therefore voted to discontinue the processing of the related standard, PH22.105, Projector Aperture for 35mm Superscope Prints With Photographic Sound.

Consideration was given to the possibility of revising the two standards on screens and mounting frames: Z22.29-1948, Theater Projection Screens; and Z22.78-1950, Mounting Frames for Theater Projection Screens. However, this was considered neither feasible nor desirable at this time and steps were taken to initiate the withdrawal of these two outdated standards.

Probably of greatest interest was the discussion on the question of reducing the temperature of the film at the projector aperture. The existing subcommittee on temperature control was reorganized with H. E. Behrens as chairman and with its scope expanded to cover all aspects of the question.

Laboratory Practice

Revision of the laboratory nomenclature standard, Z22.56-1947, has been under committee consideration for several years. At this meeting, a brief report was presented which indicated that distinct progress has been made in efforts to improve this standard and bring it up to date.

Most of the committee's time was spent in reviewing Proposed American Standard PH22.89, Printer Light Change Cueing of 16mm Negatives, and the comments resulting from the letter ballot on the second draft of this proposal. The details of the third draft were spelled out, specification by specification, in an effort to work out an acceptable industry-wide standard and a new draft was approved for letter ballot of the entire committee.

Screen Brightness

The Motion Picture Research Council submitted a proposal specifying the bright-

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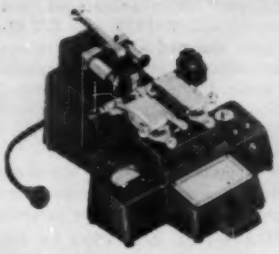

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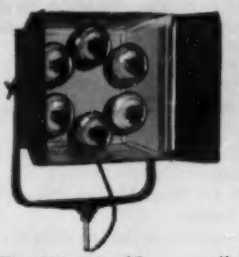

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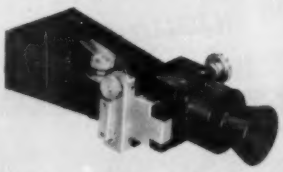

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ness of directional screens which merited appreciable discussion and which is to be submitted to the entire committee for more detailed study.

Several months prior to the meeting, the committee had been canvassed as to their views on the Draft ISO Proposal, Screen Luminance of White Matte Screens, and whether American Standard PH22.39, Screen Brightness for 35mm Motion Pictures, should be revised to be in accord with the ISO proposal. The replies, for the most part affirmative, were analyzed at the meeting and a decision was taken to proceed with a revision of PH22.39-1953 to bring it in line with the international proposal.

The chairman initiated a discussion on the philosophy of screen brightness standardization to develop a needed long-range program of work. The aim was to outline the areas requiring industry-wide standardization and to determine whether standards should be set for the review room, for the theater or possibly separate standards for each. A task force is to be appointed to propose as many drafts as can be established now and to outline which specific problems must be solved by further engineering work and research.

16 & 8 mm

This meeting opened with a review of the status of the active projects:

PH22.7, 16mm Motion-Picture Camera Image

PH22.19, 8mm Motion-Picture Camera Image

Comments on the last draft of these two standards had indicated the need for new drafts. These were submitted by the chairman, reviewed and approved with modifications for letter ballot of the entire committee.

PH22.8, Projected Image Area of 16mm Motion-Picture Film

PH22.28, Projected Image Area of 8mm Motion-Picture Film

PH22.107, Film Spools for 8mm Motion-Picture Cameras

These three standards were published in the *Journal* for trial and comment, the first two in May 1956 and the third in January 1956. A question was raised respecting the values of A_1 and B_1 of PH22.107, whether they should be 38½° instead of 39½° as published. This question is now under study and should be resolved shortly.

PH22.79-1950, 16mm Sound Projector Test Film

The reaffirmation of this standard is now being considered by ASA Sectional Committee PH22.

The two 16mm snake-track test film standards, Z22.80-1950 and Z22.81-1950, had been assigned about a year ago to a subcommittee for study and preparation of new drafts. In view of the reorganization of the Sound Committee (reported below) it was decided to shift this project to the Sound Committee.

Two standards and a Recommended Practice came up for review in accord with the periodic five-year review procedure:

PH22.74-1951, Zero Point for Focusing Scales on 16mm and 8mm Motion-Picture Cameras

PH22.76-1951, Mounting Threads and Flange Focal Distances for Lenses on 16mm and 8mm Motion-Picture Cameras

Recommendations for 16mm and 8mm Sprocket Design

It was decided to reaffirm the first, revise the second in form and content and to revise the last in form only.

Work had been initiated in 1948 on a standard for 16mm camera spools but this had been tabled due to the press of more urgent standards activity. This project was now placed in an active status and the basis for a new draft was outlined.

Preparation of a 16mm projection practice booklet for the layman has been a long standing committee objective. The difficulties in advancing this project were reviewed and new plans were made to produce this valuable booklet.

In addition, the committee reviewed questions on special 16mm reels, 16mm screen brightness, a 16mm CinemaScope test film and international standards activities.

Sound

Announcement was made of a new organizational structure for all Society sound activities. Heretofore, the responsibility for different sound projects had been divided among several committees: 16 & 8mm photographic sound — 16 & 8mm Committee, 16mm and 8mm magnetic sound — Magnetic Recording Subcommittee, 35mm photographic sound — Sound Committee, 35 mm magnetic sound — either the Sound Committee or the Magnetic Subcommitee. Review of this chaotic condition by the Engineering Vice-President and chairmen of the Sound, Magnetic Recording and 16 & 8mm Committees led to the decision to dissolve the Magnetic Recording Subcommittee and to make the Sound Committee responsible for all sound activity regardless of associated film width or nature of recording and reproducing media. The committee has been enlarged so that it will have the forces to handle its expanded program.

PH22.51, Intermodulation Tests, 16mm Variable-Density Photographic Sound, was published in the January 1956 *Journal* for trial and comment. The committee reviewed a criticism that had been received and deemed it of sufficient validity to warrant referring this standard back to the Sound Committee for resolution of the questions raised.

A new proposal for four magnetic sound records on fully-coated 35mm film, akin to an international proposal in process, was reviewed and approved for letter ballot of the entire committee.

A proposed standard for four magnetic sound records on anamorphic prints has been under consideration for over a year. The only question holding up further processing of this standard was the width of the #4 track, 41 mils vs. the initial proposal of 29 mils. At this point, it was decided to go ahead with the 41 mils and to circulate a new draft for letter ballot of the entire committee.

Lastly, questions relating to international standardization were reviewed. The U.S. delegate on Working Group G of ISO/TC

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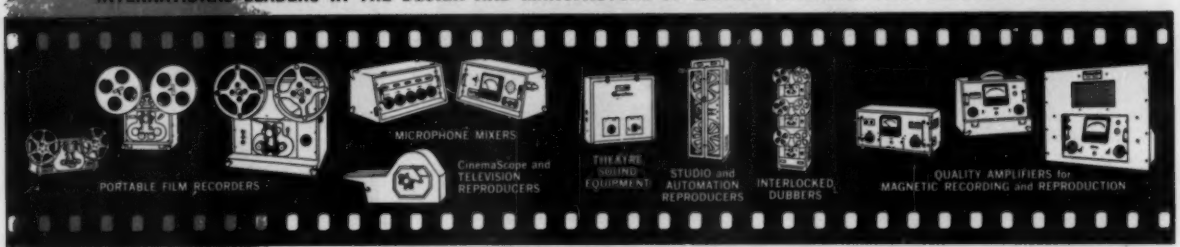

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SAN FRANCISCO—Brooks Camera Co., 45 Kearney St., San Francisco, Calif. EXbrook 2-7348.

CANADA—Alex L. Clark, Ltd., 3745 Bloor St., Toronto 18, Ontario. BEImont 1-3303.

36 presented his reasons for wishing to cast a negative vote on a proposal for 35 mm prints with one optical and two magnetic sound tracks. His position was supported fully by the committee.

Magnetic Recording

The major question facing the subcommittee was the picture-sound separation in 16mm magnetic sound projectors. At an open forum prior to this meeting RCA had announced their acceptance of the 28-frame separation proposal. This position was reaffirmed at the meeting and it was unanimously voted to submit this proposal to the Sound Committee for further processing as an American Standard.

American Standard PH22.87-1953, 100-Mil Magnetic Coating on 16mm Film, Perforated One Edge, was reviewed and it was decided to further revise this standard by adding a balance stripe to the diagram with a notation that use of a balance stripe is optional.

Note was taken of the development and production of a magnetic signal level test film. The discussion centered on the establishment of a shorthand term for simplifying reference to the level of the recorded signal.

There was a very lengthy discussion concerning the value of a standard magnetic sound reproduce characteristic. This was questioned on the ground that this characteristic refers to an idealized magnetic head and thus omits the major variable, the differences resulting from the reproduce head itself. In the end, it was concluded that a standard reproduce characteristic would have significance only if used in conjunction with a standard multifrequency test film. It was felt that inasmuch as the Society has such a test film as well as a magnetic level test film, it is now possible to produce magnetic sound records which are completely interchangeable in differing equipments.

A 16mm magnetic flutter test film and a proposed standard for this test film had been under consideration for some time but had been held in abeyance because of questions concerning the effect of shrinkage and film compliance. At this point, the committee recommended that the Society proceed with the production of a sample test film which it was felt would provide the most effective tool for determining the significance of these factors.

The chairman reported the reorganization of the Sound Committee as noted above, that the subcommittee was being dissolved and that therefore this was its last meeting. The many accomplishments were reviewed and appreciation was expressed for the fine cooperative spirit of all the members manifested through the life of the subcommittee. In turn, the members applauded the leadership supplied by their chairman, E. W. D'Arcy.

Television

At the previous meeting work had been initiated on a standard for 16mm television projectors for use with the vidicon tube. Progress on this work was reviewed and plans were made for furthering this activity.

The problem of centering slides in a projector was analyzed. At this time there is no standard specifying a reference edge for indexing slides. A task force was appointed to study this question and to draft a recommended practice.

Comments invited on the Society's color television test film and slides were, in the main, very favorable. The sole problem has been adequate control of the gray scale and correction of this is now under way.

Methods of insuring proper color balance for different film sources of broadcast material were considered, including the possibility of utilizing in the leader a characteristic scene from the feature show or spot announcement. The consensus was that there is insufficient experience at this point to develop any specific proposal and a task force was appointed to study this question.

Note was taken of the developments in magnetic video recording. The early establishment of a coordinating center was considered advisable and it was felt that this committee would be admirably suited for this role. This question has to be decided at a higher level and in consultation with the other organizations in the field.—*Henry Kogel*, Staff Engineer.

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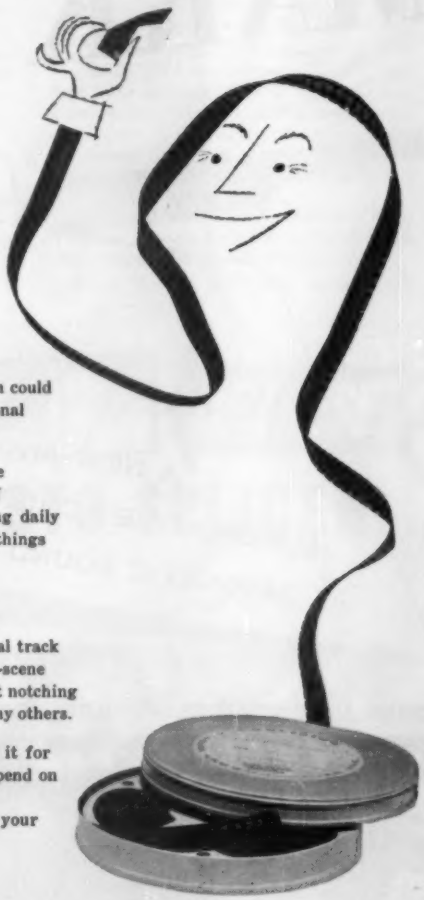

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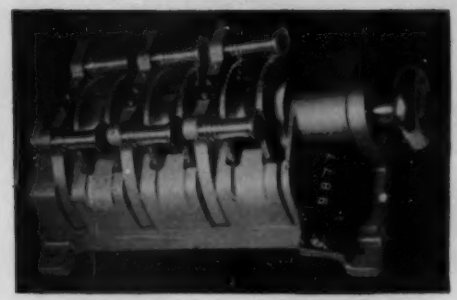

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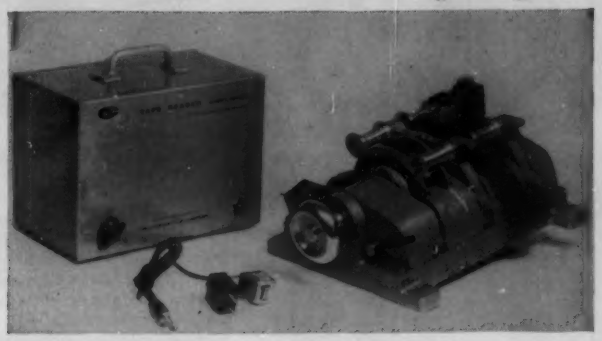

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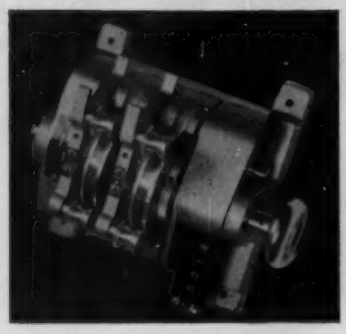

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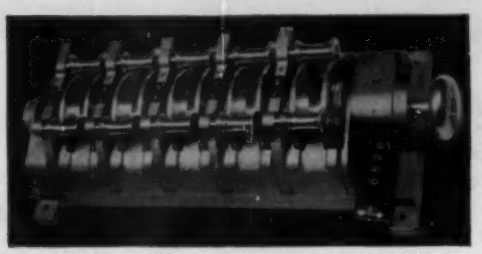

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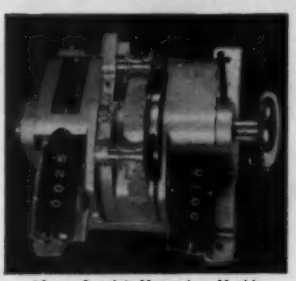

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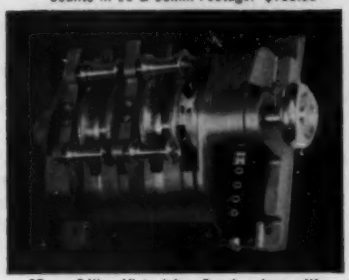

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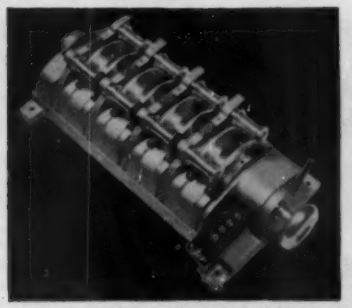

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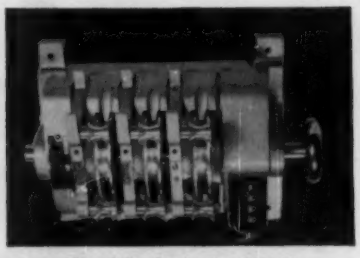

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section reports

The Central Section met on June 18 at the Western Society of Engineers, Chicago, with an attendance of 55. A paper, "Automatic Timing of Color Negatives," by John A. Stott, William R. Weller and J. Edward Jackson of the Color Technology Div., Eastman Kodak Co., was read by Mr. Weller. The paper outlines a scientific approach to color timing. The authors have developed a concept which may shorten or entirely eliminate some of the preliminary tests that must be made. The authors measure integrated transmission to red, green and blue light of representative color negative scenes. The readings are then statistically correlated to the printer setting which produced acceptable picture quality for each of the representative scenes. To test the method, the authors arranged to print several films at one of the film laboratories. These films were projected for review and discussion.—*H. H. Brauer*, Secretary-Treasurer, c/o Bell & Howell Co., 7100 McCormick Rd., Chicago 45.

The Pacific Coast Section met on June 19 in the Walt Disney Studio, Burbank, Calif. Approximately 175 persons attended. Three papers on television lighting that had been presented at the SMPTE Convention in New York were read. Franklin J. Gaskins, Technical Supervisor for NBC read Gerald F. Rester's report on the survey conducted to determine current lighting practices of TV stations engaged in live color-program origination. William H. Copeland, Engineer in charge of color TV for CBS presented a paper prepared by E. Carlton Winckler covering the technique developed in lighting network programs. He discussed the use of interesting combinations of all types of lighting equipment as well as a wide range of wattages to obtain the balance and intensities necessary for the color cameras while operating within the dramatic structure. Techniques and methods were described in detail. John R. Kennedy, liaison engineer, Pacific Division, NBC, read a paper by Robert W. Byloff which traced the evolution of the present lighting systems for color TV studios to those first used in monochrome television. A typical system was studied along with quantitative design considerations. A number of interesting slides of NBC lighting facilities were shown.—*John W. DuVall*, Secretary-Treasurer, c/o E. I. du Pont de Nemours & Co., 7051 Santa Monica Blvd., Hollywood 38.

The Northwest Section met on June 26 at the Palmer Films Studios, San Francisco. Approximately 27 members and guests attended. Robert W. Hufford, Eastman Kodak Co., Hollywood, read a paper on "Color Kinescope Recording on Embossed Film," by C. H. Evans and R. B. Smith, Eastman Kodak Co., Research Laboratories, Rochester 4, N.Y. The new film was demonstrated by operating two projectors in synchronism. Prints from the new embossed film and the older type of Eastman color film were shown simultaneously, side by side, to demonstrate the improvement in prints made from the new film,especially in flesh tones.—*R. A. Isberg*, Secretary-Treasurer, Consulting Engineer, 2001 Barbara Drive, Palo Alto, Calif.

Education, Industry News

The Second International Industrial and Labor Film Festival will be held during December 1956 in Brussels, Belgium. The purpose of the meeting is to stimulate interest in films used in industrial research, vocational training, and analysis of labor problems. Films used in the discussions may be made in any country but will not be accepted if made before December 1952. More detailed information can be obtained from La Cinémathèque de Belgique 23, rue Ravenstein, Brussels, Belgium.

Closed circuit television as an integral part of a county-wide teaching program will be introduced in Washington County, Md., when school opens in September. More than 6000 pupils in two high schools and six elementary schools will receive an important part of their daily instruction by television and by September 1958 the teaching-by-television program is expected to reach about 20,000 pupils in the 47 schools in the county.

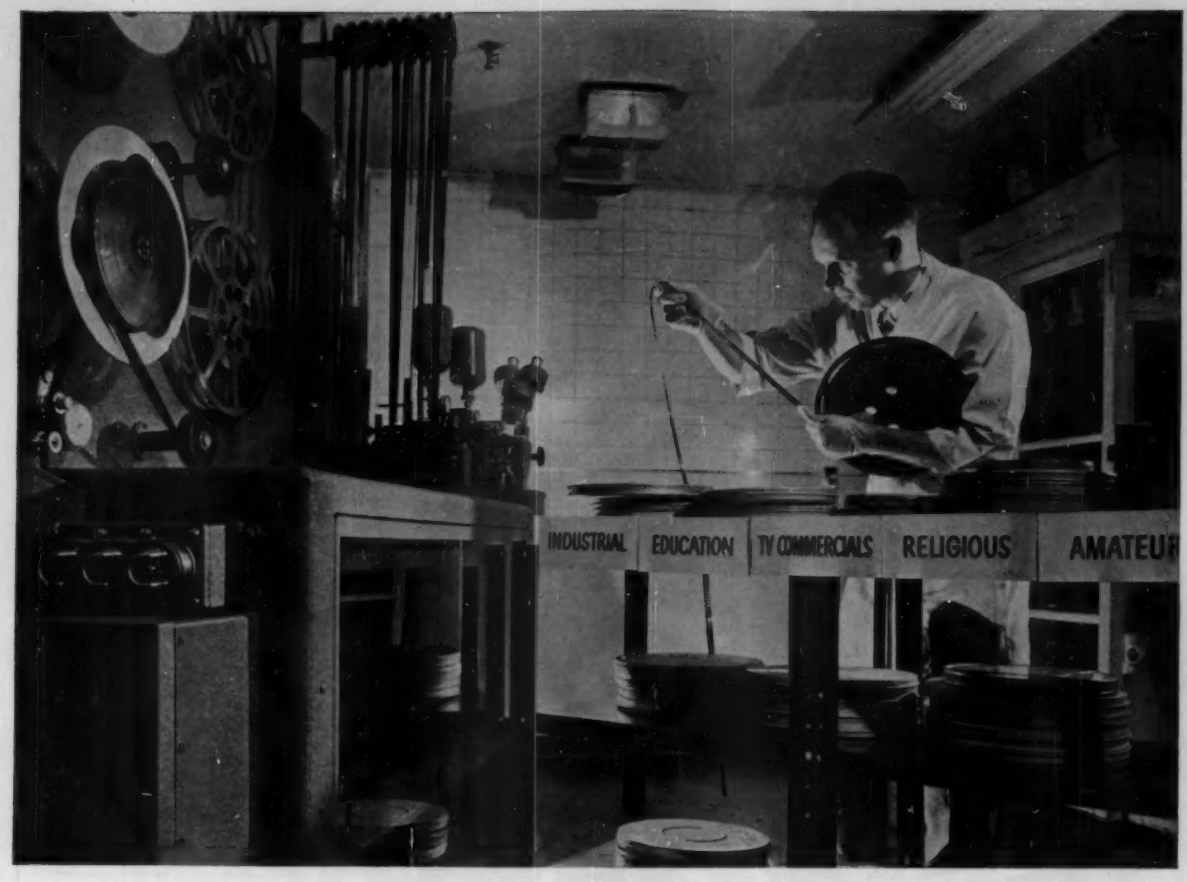
Equipment for the school installations, will be contributed by electronics manufacturers through the Radio Electronics Television Manufacturers Association (RETMA). Funds to provide for the training of personnel to administer the program will be granted by the Ford Foundation.

Announcement of the plan, described as a research project, came after months of discussion by leaders in education, and representatives of RETMA and the Ford Foundation. One of the goals aimed at by sponsors of the project is to find a solution for the serious problems brought about by the growing shortage of teachers; the lack, in many areas, of adequate facilities; and the growing increase in enrollments.

If this tryout is successful it may revolutionize educational techniques throughout the nation affecting not only classroom instruction and the training of teachers but the architecture of future school buildings.

Arthur J. Hatch has been elected President of the Strong Electric Corp., Toledo, Ohio. He joined the engineering staff of the company in 1935 and was elected Vice-President in 1947. Strong Electric Corp. is a subsidiary of General Precision Equipment Corp.

William G. Straube, Sales Manager for the Pacific Optical Corp., has been appointed Vice-President and General Sales Manager of the newly organized IMP Engineering Corp., 1591 Crossroads of the World, Hollywood. IMP is engaged in work for the U.S. Department of Defense in the field of photographic testing and missile systems.



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Biographical Note

Professor John Eggert, Head of the Photographic Department of the Federal Institute of Technology in Zürich, Switzerland, celebrated his 65th birthday on August 1, 1956. He is one of the outstanding figures in scientific photography in Europe and his contribution towards leading photographic research away from empirical know-how to scientific knowledge is well known and recognized throughout the world.

John Eggert, a student of Prof. W. Nernst, received his doctorate from the University of Berlin in 1914. In 1921 he was given the task of building a research department for the Agfa Company. This became in 1928 the famous "Wissenschaftliches Zentrallaboratorium" (Central Scientific Laboratory) of this Company which published, up to 1939, six volumes of fundamental scientific papers. Simultaneously, he was a professor of physical chemistry, particularly photochemistry and photography, at the University of Berlin. This assignment ended in 1937 for political reasons. His political integrity led to imprisonment for him and his family near the end of World War II. They were freed by the American army, and high ranking officers helped them to Munich in the Western Zone. In this city he was professor of physical chemistry at the Institute of Technology from 1945 to 1946. In this year he accepted the offer of his present position at the Federal Institute of Technology in Zürich, Switzerland. In this country, unaffected by the limitations of the postwar years and by the interests of private industries, he found a challenging opportunity to reorganize the Photographic Department of this school and to intensify its research activities. His success is illustrated by the fact that his former students hold important research positions in industries of at least three continents. His strong belief in free exchange of fundamental scientific knowledge made him successfully cooperate with a group of other scientists in reviving the annual "International Photographic Congress" which had been discontinued during the war.

Dr. Eggert's contributions to photographic science are reflected in a number of awards. In 1950 he was awarded an honorary degree by the Institute of Technology in Karlsruhe, Germany, "in recognition of his work in physical chemistry and scientific photography." In the same year he was awarded the Progress Medal of the Royal Photographic Society of Great Britain "in recognition of his classical work in latent image theory and in particular on the quantum efficiency, his work on the effect of x-rays on photographic emulsions and in evolving methods of standardization of photographic speed and graininess." In 1951 the "Société Française de Photographie et Cinematographie" awarded Dr. Eggert its Péligot Medal "in recognition of his work in scientific photography for the past 30 years." In 1953 he was elected an Honorary Fellow of the Royal Photographic Society of Great Britain.—*R. R. Zemp and B. Meerkamper.*

New Members

The following members have been added to the Society's rolls since those last published. The designations of grades are the same as those used in the 1956 MEMBERSHIP DIRECTORY.

Active (M) Associate (A) Student (S)

This is the fourth list of New Members supplementing the April Journal, Part II, Directory.

Bence, Charles W., Film Techn., Technicolor Motion-Picture Corp. Mail: 1041 N. Avon St., Burbank, Calif. (A)

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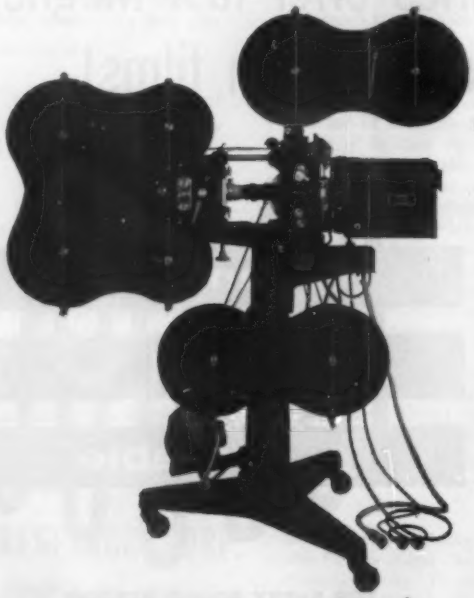

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Bogart, John A., Eng., Unicorn Eng. Corp. Mail: 1775 N. Las Palmas, Apt. 217, Hollywood. (A)

Boyer, Carl A., Film Techn., Technicolor Motion-Picture Corp. Mail: 18227 Van Owen, Reseda, Calif. (A)

Brown, Charles M., Production Manager, Stephens Mfg. Corp. Mail: 1655 Highland Ave., Glendale 2, Calif. (M)

Bue, Paul Andrew, Boston Univ. Mail: 105 Walker St., Lowell, Mass. (S)

Cerchione, Angelo John, Cambridge Sch. Radio & TV. Mail: 92 Longview Ave., Lake Hiawatha, N.J. (S)

Coggins, Donald I., Tech. Sales, Sylvania Electric Co. Mail: 14 Philips Rd., Melrose, Mass. (M)

Corso, John Jr., Mot.-Pic. Techn., W. A. Palmer Films, Inc., 611 Howard St., San Francisco. (A)

Curtis, Nicholas, Designer, Trans-Lux Corp., 627 Madison Ave., New York. (M)

DeCastro, Joseph, Business Mgr., Hillcrest Color Labs., Inc., 21 Spencer St., Cubao, Q.C., Philippines. (A)

De Santos, Demetrio, Chief Sound Recording Engr., Premiere Productions, Inc. Mail: 16 Alcman, Sta. Mesa Heights, Quezon City, Philippines. (A)

Dollard, Henry Louis Jr., Chemist, Technicolor Motion-Picture Corp. Mail: 16519 Simonds St., Granada Hills, Calif. (A)

Dowling, David Fraser, Boston Univ. Mail: 15 Rockland St., Wellesley Hills, Mass. (S)

Filice, Peter Carmen, Television Tech., KRON-TV. Mail: 3307 Sweet Dr., Lafayette, Calif. (A)

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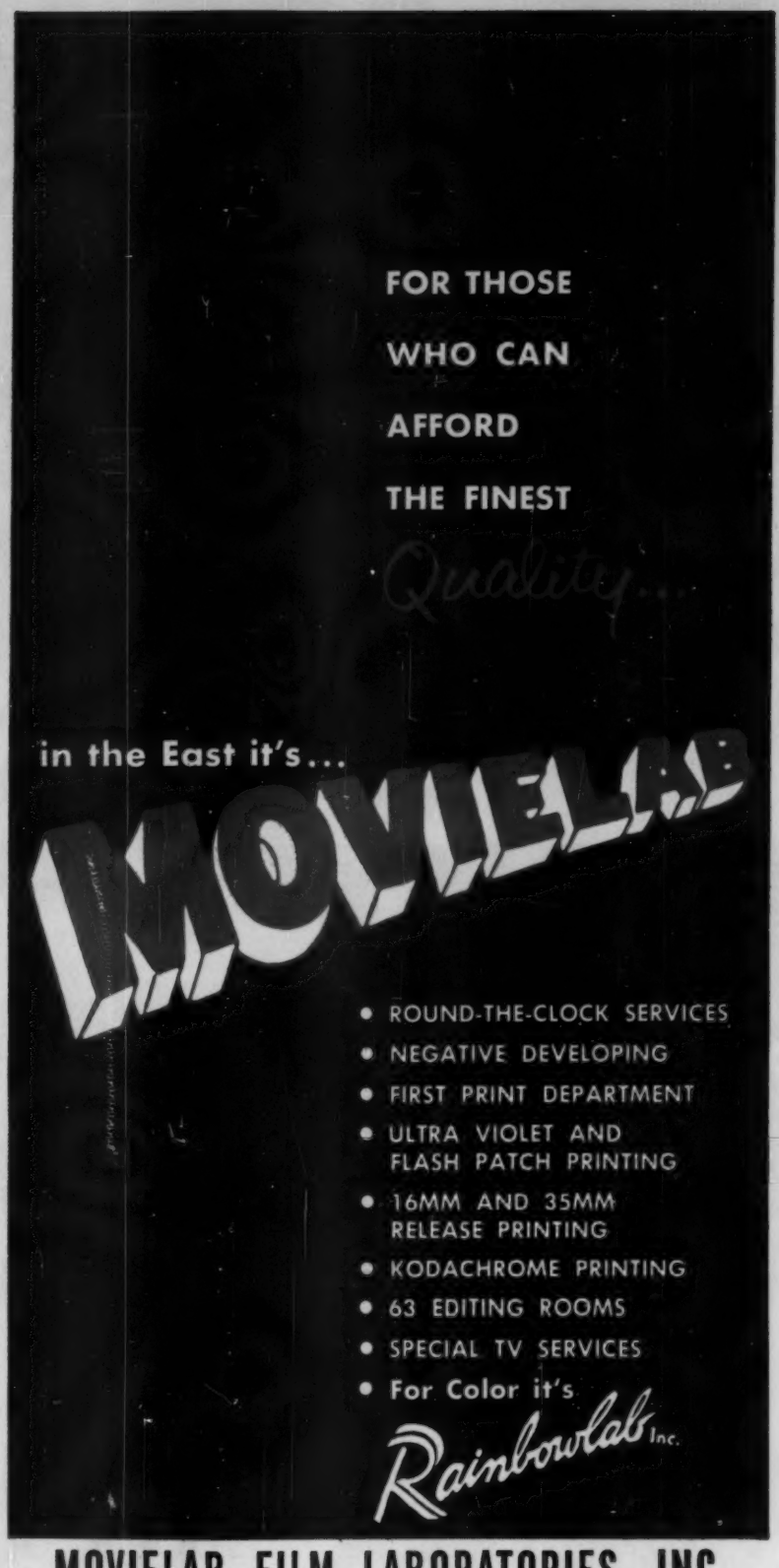

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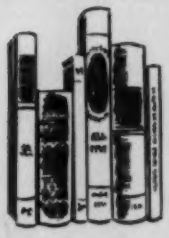

books reviewed

Annuario del Cinema Italiano 1954-1955

Published by Cinedizione, Via Po 50, Rome. Approx. 1020 pp. Price 5000 lire.

The list of motion-picture terms in five languages which was published in the February 1956 *Journal* has been the subject of numerous comments and inquiries. Readers interested in this field should know that what appears to be an excellent example of such a listing, on a far more comprehensive scale than we have yet been able to accomplish, may be found in the *Annuario del Cinema Italiano 1954–1955*.

This handbook of the Italian motion-picture industry is a highly useful compendium of information, quite apart from the glossary, distinguished by a quite outstanding clarity of organization and a minimum of advertising. The various sections include addresses of organizations and individuals in the industry; legislation, with detailed

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information on wages and prices; statistics on Italian film production since 1930; and an extremely comprehensive directory of companies, publications, theaters, exchanges, trade unions and other organizations of interest to the industry both in Italy and abroad. Even though the user may not be entirely at home with the Italian language the book is so well arranged that it is actually easier to use than some of the similar handbooks printed in English.

The glossary of motion-picture terms, in Italian, English, French and German, is arranged alphabetically and covers more than 2000 words. There are occasional misprints and some translations with which every reader will be able to disagree, but by and large the level of accuracy seems to be extraordinarily high and for anyone who needs equivalents in any of the four languages given this glossary will be of very great value indeed.—*D.C.*

Photographic Optics

11th revised ed. by Arthur Cox. Published (1956) Focal Press, 31 Fitzroy Sq., London, W1. 375 pp. Illus. Graphs. 4¾ × 7¾. Price $5.75

Although primarily for still photography, this book has material of value for cine and TV technicians. Of particular interest is the consolidated treatment of lenses of Asiatic, European and American origin. Recent large-aperture types up to *f*/1.2 are described in this new edition. Specific lenses are identified by their trade names for positive recognition, and lenses in the same design category are conveniently grouped. Optical schematics are given.—*Bernard D. Plakun*, General Precision Laboratory Inc., Pleasantville, N.Y.

Actes du Colloque International: Les Techniques Nouvelles Appliquées au Cinema.

Published by Commission Superiéure Technique du Cinéma, 92 Champs-Élysées, Paris 8. 156 pp. 8¼ × 11¾ in. Illus. Price 1500 francs.

In this book are published the transactions of an international conference on new motion-picture techniques held in Paris, May 12–16, 1955. The conference was arranged by the Commission Supérieure Technique du Cinéma Français and motion-picture engineers from Belgium, Great Britain, Italy, New Zealand, East Germany, West Germany, Switzerland, the U.S.S.R. and Unesco took part in the discussions.

The papers are grouped into five sections. The first, on sound recording and reproduction, has papers on the comparative qualities of photographic and magnetic sound, the problem of sound quality in relation to the various new stereophonic systems, stereophonic techniques in the motion-picture theater, sound recording and reproducing problems, magnetic sound recording on film and its use in radio and television.

The second section covers wide-screen projection, new lighting techniques, taking lenses of variable focal length, television lighting and large-screen television.

The third section is concerned with color and is subdivided into groups of papers dealing with picture composition and color contrast, printing and processing requirements, and descriptions of the Agfa, Eastman, Gevaert and Ferrania color systems.

In the fourth section the results reached in the preceding three sections are synthesized, and in the fifth and last a report is given of a special meeting of the French office of standardization for the motion-picture industry, under the chairmanship of Andre Debrie.—*D.C.*

60 Ans d'Evolution. With this special issue *La Technique Cinématographique* celebrates its 25th anniversary and, at the same time, the 60th anniversary of the birth of motion pictures (an event which apparently took place on December 28, 1885). The history and development of the industry in France, as well as its contemporary problems, are dealt with in a number of articles by some of the leading French technicians, while contributions from the U.S., England, Germany, Italy, Spain and Belgium cover developments in those countries. The issue, priced at 600 francs, is available from *La Technique Cinématographique*, 54 Rue de Clichy, Paris 9.

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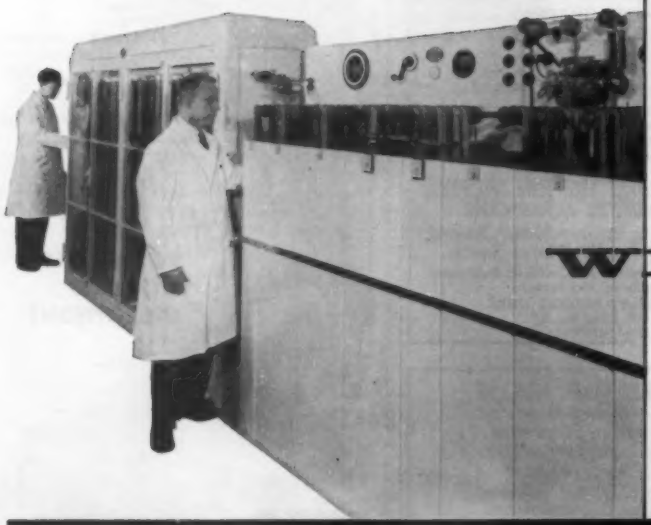

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National Telemetering Conference, Aug. 20–21, Biltmore Hotel, Los Angeles
Western Electronic Show and Convention, Aug. 21–24, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles.
Biological Photographic Association, Aug. 27–31, Powers Hotel, Rochester, N. Y.
High-Speed Photography, Third International Congress, including exhibit of high-speed photographic and cinematographic equipment and instrument aids; sponsored by Britain's Dept. of Scientific and Industrial Research, Sept. 10–15, London.
American Society of Mechanical Engineers, Sept. 10–12, Denver.
American Society for Testing Materials, Second Pacific Area National Meeting, Sept. 17–21, Hotel Statler, Los Angeles.
Eleventh Annual International Instrument-Automation Conference and Exhibit, ISA, Sept. 17–21, New York Coliseum, New York.
Theater Owners of America, Inc., Annual Convention, Sept. 19–25, Coliseum, New York.
Industrial Electronics Conference IRE, AIEE, Sept. 24–25, Hotel Manager, Cleveland, Ohio.
Audio Engineering Society, Annual Convention, Sept. 26–29, New York Trade Show Bldg., New York.
New York High Fidelity Show, Sept. 27–30, New York Trade Show Bldg., New York.
Canadian IRE Convention and Exposition, Oct. 1–3, Automotive Bldg., Exhibition Park, Toronto, Ont., Canada.
National Electronics Conference, Inc., 12th Annual Conference, Oct. 1–3, Hotel Sherman, Chicago.
National Association of Educational Broadcasters, Oct. 16–18, Atlanta.
80th Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 8–12, Ambassador Hotel, Los Angeles.
Optical Society of America, Oct. 18–20, Lake Placid Club, Essex County, N. Y.
American Standards Association, Annual Meeting, Oct. 22–24, Hotel Roosevelt, New York.
Ninth Annual Conference on Electrical Techniques in Medicine and Biology, Nov. 7–9, Governor Clinton Hotel, New York.
Acoustical Society of America, Nov. 15–17, Los Angeles.
Radio Engineering Show and IRE National Convention, Mar. 18–21, 1957, New York Coliseum, New York
American Institute of Chemical Engineers, Dec. 9–12, Hotel Statler, Boston, Mass.
81st Semiannual Convention of the SMPTE, including Equipment Exhibit. Apr. 29-May 3, 1957, Shoreham Hotel, Washington, D. C.
82nd Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 4-9, 1957, Philadelphia-Sheraton, Philadelphia.
83rd Semiannual Convention of the SMPTE, including Equipment Exhibit, April 21–26, 1958, Ambassador Hotel, Los Angeles.
84th Semiannual Convention of the SMPTE, Oct. 20–24, 1958, Sheraton-Cadillac, Detroit.
85th Semiannual Convention of the SMPTE, including International Equipment Exhibit, May 4-8, 1959, Fontainebleau, Miami Beach.
86th Semiannual Convention of the SMPTE, including Equipment Exhibit, Oct. 6-10, 1959, Hotel Statler, New York.

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Berndt-Bach, Inc.
Bijou Amusement Company
Buensod-Stacey, Inc.
Burnett-Timken Research Laboratory
Byron, Inc.
CBS Television
The Calvin Company
Capital Film Laboratories, Inc.
Oscar F. Carlson Company
Century Projector Corporation
Cineffects, Inc.
Cinema Engineering Company
Cinema-Tirage L. Maurice
Cine Products Supply Corporation
Geo. W. Colburn Laboratory, Inc.
Consolidated Film Industries
DeLuxe Laboratories, Inc.
Dominion Sound Equipments Limited
Du Art Laboratories, Inc.
E. I. du Pont de Nemours & Co., Inc.
Eastman Kodak Company
Elgeet Optical Company, Inc.
Max Factor & Co.
Federal Manufacturing and Engineering Corp.
Fordel Films, Inc.
General Electric Company
General Film Laboratories Corporation
General Precision Equipment Corp.
- Ampro Corporation
- Askania Regulator Company
- General Precision Laboratory Incorporated
- The Hertner Electric Company
- International Projector Corporation
- J. E. McAuley Mfg. Co.
- National Theatre Supply
- The Strong Electric Company

W. J. German, Inc.
Guffanti Film Laboratories, Inc.
Hollywood Film Company
Houston Fearless
Hunt's Theatres
Hurley Screen Company, Inc.
The Jam Handy Organization, Inc.
Kling Photo Corp. (ARRI Div.)
Kollmorgen Optical Corporation
Lorraine Carbons
Major Film Laboratories Corporation
J. A. Maurer, Inc.
Mecca Film Laboratories, Inc.
Mitchell Camera Corporation
Mole-Richardson Co.
Motiograph, Inc.
Motion Picture Association of America, Inc.
- Allied Artists Products, Inc.
- Columbia Pictures Corporation
- Loew's Inc.
- Paramount Pictures Corporation
- Republic Pictures Corp.
- RKO Radio Pictures, Inc.
- Twentieth Century-Fox Film Corp.
- Universal Pictures Company, Inc.
- Warner Bros. Pictures, Inc.

Motion Picture Printing Equipment Co.
Movielab Film Laboratories, Inc.
National Carbon Company
- A Division of Union Carbide and Carbon Corporation

National Cine Equipment, Inc.
National Screen Service Corporation
National Theaters Amusement Co., Inc.
Neighborhood Theatre, Inc.
Neumade Products Corp.
Northwest Sound Service, Inc.
Panavision Incorporated
Pathe Laboratories, Inc.
Polaroid Corporation
Producers Service Co.
Projection Optics Co., Inc.
Radiant Manufacturing Corporation
Radio Corporation of America
Reid H. Ray Film Industries, Inc.
Raytone Screen Corp.
Reeves Sound Studios, Inc.
S.O.S. Cinema Supply Corp.
SRT Television Studios
Shelly Films Limited (Canada)
The Stancil-Hoffman Corporation
Technicolor Motion Picture Corporation
Terrytoons, Inc.
Titra Film Laboratories, Inc.
United Artists Corporation
Alexander F. Victor Enterprises, Inc.
Wenzel Projector Company
Westinghouse Electric Corporation
Westrex Corporation
Wilding Picture Productions, Inc.
Wollensak Optical Company